MAY 1959

Agricultural Engineering

The Journal of the American Society of Agricultural Engineers

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The Application of Soil Fumigants | 268

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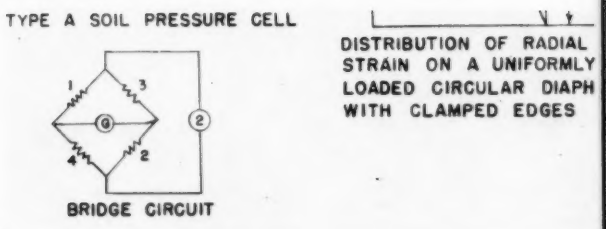
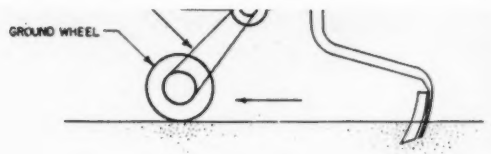
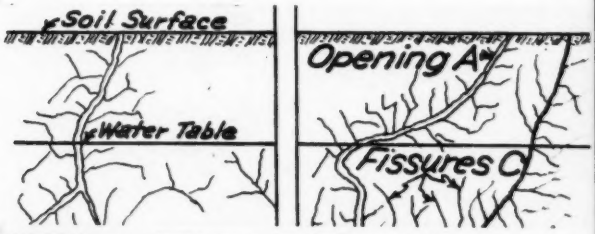

TYPE A SOIL PRESSURE CELL
BRIDGE CIRCUIT
DISTRIBUTION OF RADIAL STRAIN ON A UNIFORMLY LOADED CIRCULAR DIAPH WITH CLAMPED EDGES



Fumigants or nematocides applied with ground-driven gea



CASE HISTORIES

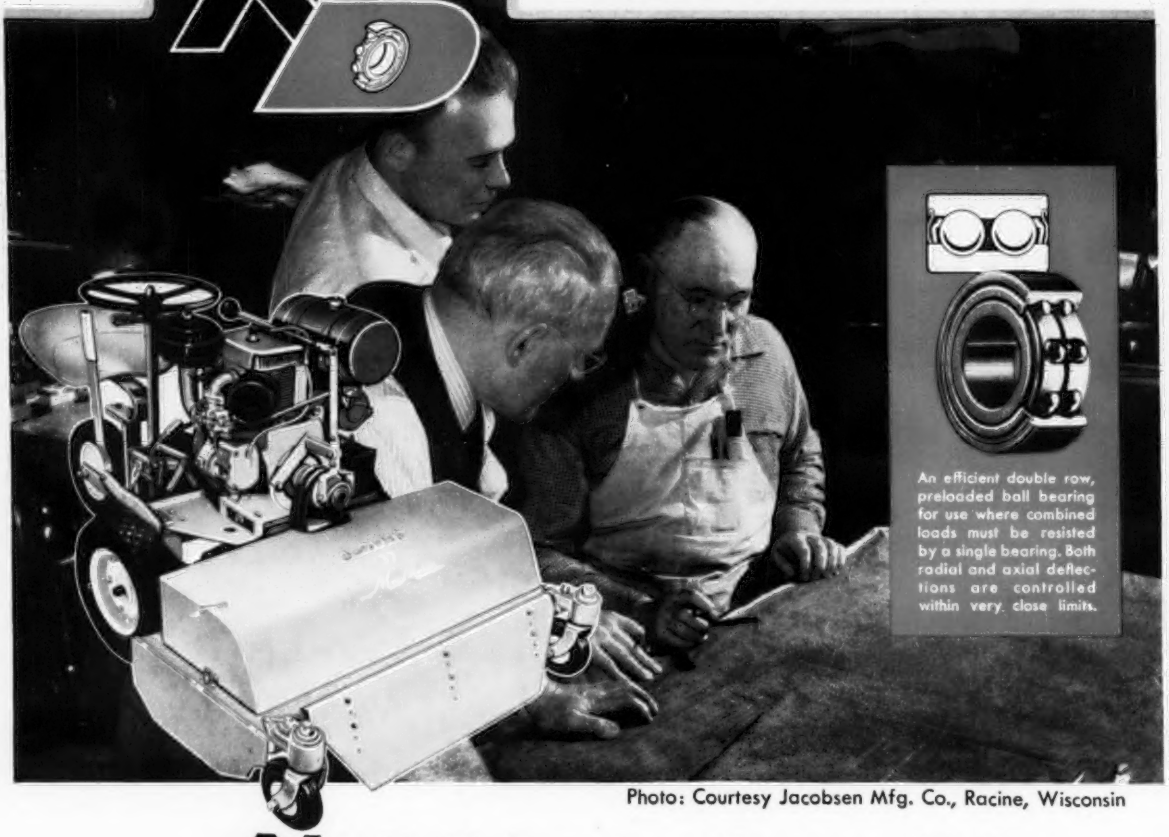

An efficient double row, preloaded ball bearing for use where combined loads must be resisted by a single bearing. Both radial and axial deflections are controlled within very close limits.

Photo: Courtesy Jacobsen Mfg. Co., Racine, Wisconsin

Ball Bearing Design Helps Cut Power Mower Costs $4.29 Per Unit!

CUSTOMER PROBLEM:

Require bearing design that will help reduce production costs of power mower without affecting mower's high quality and performance.

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N/D Sales Engineer, working with company engineers, recommended a new, more efficient cutter housing design utilizing three precision New Departure production double row ball bearings. These high capacity dual purpose bearings resist heavy radial and thrust loads in any combination. The conversion accounted for a parts and assembly-time cost savings of $4.29 per mower. In addition, the manufacturer is able to promise mower users years of trouble-free performance, while pricing more competitively at retail!

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Replacement ball bearings available through United Motors System and its Independent Bearing Distributors

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now! PUSH-BUTTON power lubrication

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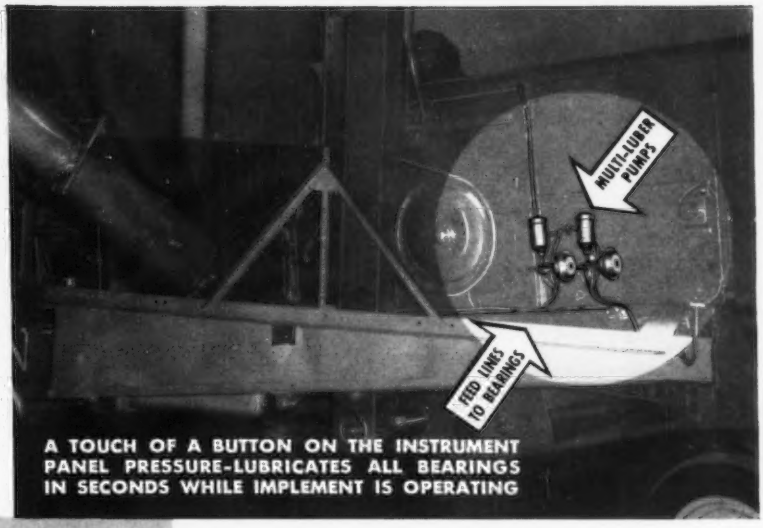
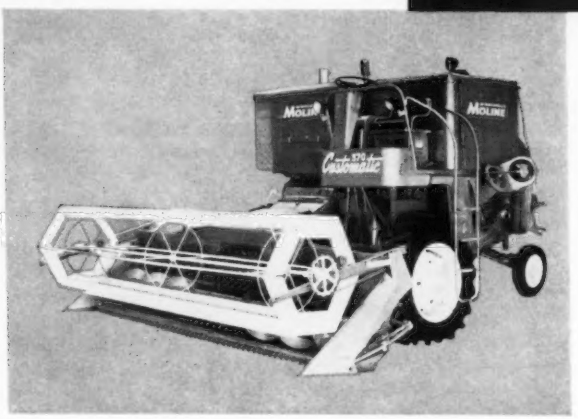
Lincoln Multi-Luber* SYSTEM



A TOUCH OF A BUTTON ON THE INSTRUMENT PANEL PRESSURE-LUBRICATES ALL BEARINGS IN SECONDS WHILE IMPLEMENT IS OPERATING



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DESIGN WITH LINCOLN MULTI-LUBER ON YOUR ORIGINAL EQUIPMENT...
it pays 8 ways!

1. Provides the simplest, most dependable automatic power lubrication of all bearings, simultaneously, in seconds.

2. Operator presses button on instrument panel any time engine is running. Adjacent signal light illuminates when lubrication cycle is complete.

3. Eliminates down-time and man-hours spent on implement lubrication. Assures more daylight hours of production.

4. Increases service-life of bearings and moving parts . . . reduces cost of maintenance . . . eliminates overlooking less obvious lube points.

5. Insures dealers' and users' satisfaction by increasing operating efficiency . . . reducing causes of breakdowns before they begin.

6. Keeps implements running smoothly with uniform efficiency regardless of variations in weather.

7. Prevents waste and contamination of lubricant. System is sealed to assure application of refinery-pure oil each time Multi-Luber is cycled.

8. Resists effects of dust and mud . . . sturdily built and engineered to last.

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Agricultural Engineering

Established 1920

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Note: AGRICULTURAL ENGINEERING is regularly indexed by Engineering Index and by Agricultural Index. Volumes of AGRICULTURAL ENGINEERING, in microfilm, are available (beginning with Vol. 32, 1951), and inquiries concerning purchase should be directed to University Microfilms, 313 North First Street, Ann Arbor, Michigan.

AGRICULTURAL ENGINEERING is owned and published monthly by the American Society of Agricultural Engineers. Editorial, subscription and advertising departments are at the central office of the Society, 420 Main St., St. Joseph, Mich. (Telephone: YUkon 3-2700).

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SUBSCRIPTION PRICE: $8.00 a year, plus an extra postage charge to all countries to which the second-class postage rate does not apply; to ASAE members anywhere, $4.00 a year. Single copies (current), 80 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

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C. E. Seitz Elected Honorary Member

IN RECOGNITION of his approximately forty years of distinguished service to the agricultural engineering profession, the Council of ASAE has recently elected C. E. Seitz to the grade of Honorary Member in the Society.

Mr. Seitz, who has been a member of ASAE since 1917, was born in Reno, Nevada, in 1890. After finishing work in the preparatory school in Reno, he took work at the University of Nevada from 1911 to 1912, continuing his studies at Ontario Agricultural College the following two years. As early as 1909 he had done irrigation work at the Nevada Agricultural Experiment Station, followed by two years in the engineering department of the Southern Pacific Railway. He began his first professional agricultural engineering work in Virginia in 1914 and laid groundwork for the sound growth of the profession in the state and the Southeast.

Charles E. Seitz

In 1916 he spent eighteen months on the Mexican Border with the First Virginia Cavalry, returning to Virginia in 1917 to take up extension work. Later he enlisted in the Air Service and while waiting to be called into training to become a pilot, spent several months at Iowa State College taking special work in agricultural engineering. Upon being discharged from the Air Service in 1918, he returned to Virginia and at the request of the newly appointed president, organized the department of agricultural engineering at Virginia Polytechnic Institute and became its first head in 1919, establishing the first curriculum leading to the B.S. degree in agricultural engineering in any college east of the Mississippi River. He served as head of the department until his retirement in 1954.

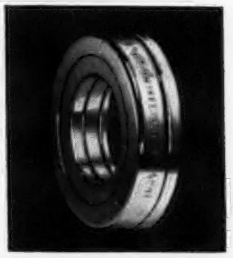
In research he personally conducted studies in land drainage, surface and overhead irrigation, dairy refrigeration and electricity on Virginia farms. He assisted power companies in establishing rural service departments, and advised with many other Land Grant Colleges in their organization of agricultural engineering departments.

In 1924 he initiated and organized the rural electrification movement in Virginia, and served as chairman of the state committee on relation of electricity to agriculture. In 1933 he prepared plans and proposals for a soil erosion control public works project to which the Soil Conservation Service assigned a half-million dollars. He was advisor to the Service, and chairman of the state Engineering Committee on Erosion Control.

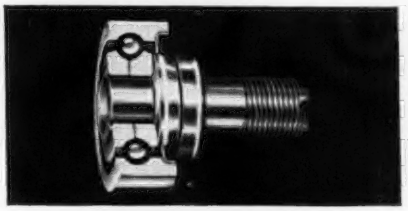
In the course of his career he has served on many state and national committees and conferences covering every aspect of his profession and some related fields. One of the more colorful was the United States-Chinese Agricultural Mission to China in 1946.

He has been a versatile writer, being author or co-author of fourteen bulletins and circulars and of 69 articles and papers. He was president of ASAE in 1932-33; served as chairman of its College Division and of the Southeast Section as well as on numerous of its committees and was a recipient of the Cyrus Hall McCormick Medal in 1951. Other memberships include the American Society of University Professors, the Virginia Academy of Science, Sigma Alpha Epsilon, Epsilon Sigma Phi, Alpha Zeta, and University Club.

The agricultural engineering building at VPI, now called Seitz Hall, stands as a tribute to the dedication and determination of C. E. Seitz. Although funds were difficult to obtain during the depression, he was able to secure a WPA grant for construction of a new building. Because the funds were inadequate, he and other staff members supervised its construction, using two skilled workmen and transient labor.

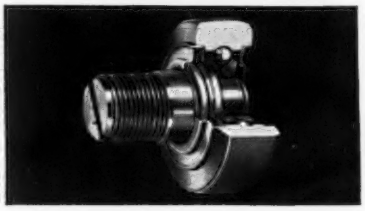


Clutch Bearings



Hay Rake Bearings

Idler Pulley Assemblies



Plunger Rollers

PIONEERING EXPERIENCE PAYS OFF FOR YOU . . . WHEN YOU USE BALL BEARING "PACKAGE UNITS" FROM BCA

You simplify production line installation and reduce manufacturing costs with "package units" designed and produced by BCA—the company that conceived and developed the ball bearing "package unit" idea. Bearing, housing and seal are combined in one rugged unit lubricated for life and sealed against water, dust and grit. BCA "package units" are available for a very wide range of applications including hay rake bearings, idler pulley assemblies, clutch bearings and plunger rollers. Count on BCA experience to provide ball bearing "package units" that are right for you and your customers . . . whether the application is unusual or routine. Bearings Company of America Division, Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.

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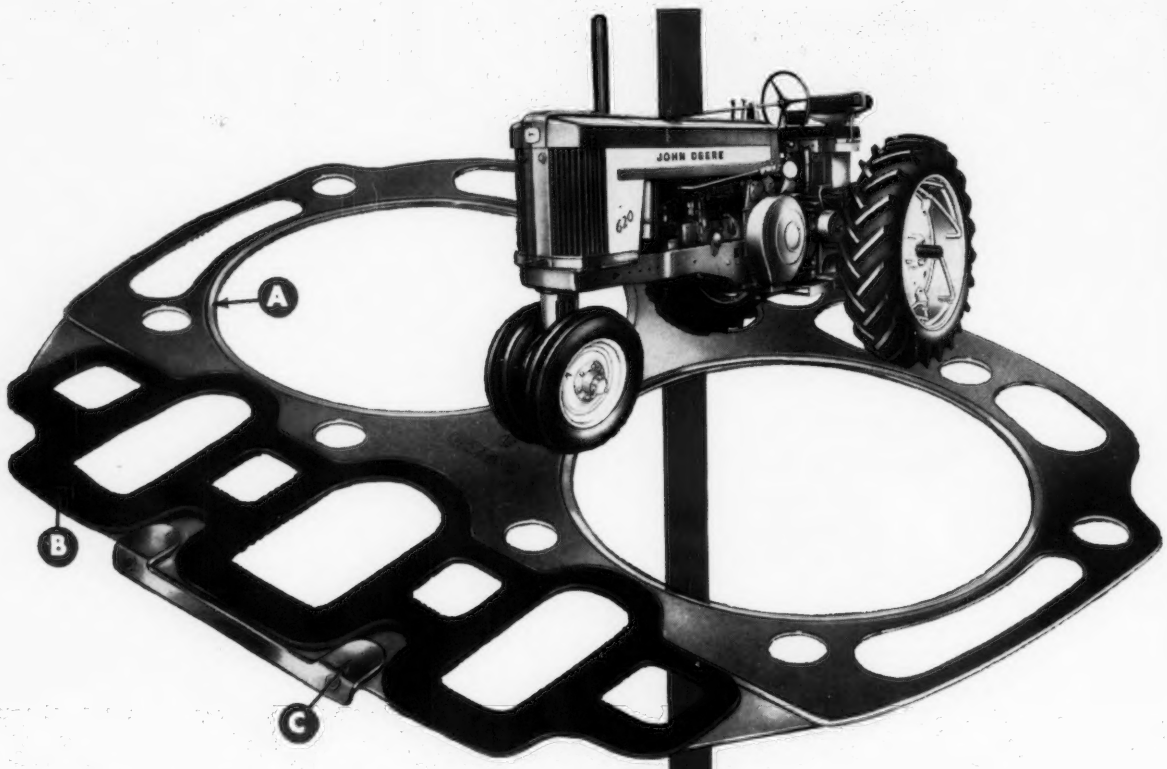

How JOHN DEERE seals an intricate block casting

JOHN DEERE engineers assume no limitations on what can be done with gaskets. For example, take the case of sealing the Model 620 tractor engine.

Intricate block design created the problem of effectively sealing the coolant ports beyond the area of stud loading. The seal would have to compensate for heat expansion and shifts of the water holes in the block casting. Compressed thickness and resilience of the gasket overall would have to be balanced to insure maximum sealing of combustion chambers, exhaust, fuel and air ports.

Solution Comes from Standard Design

How JOHN DEERE engineers in cooperation with Victor specialists solved this problem is shown here. This partial modification of the standard VIC-2-FOLD design suggests the flexibility and wide scope of economical sealing service available from Victor.

Whatever you have to seal with gaskets or oil seals, Victor's unmatched facilities are yours to use. Contact your Victor Field Engineer or the factory.

Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill.—Canadian Plant: St. Thomas, Ont.

A → **VIC-2-FOLD** modern metal-asbestos design insures tight sealing of combustion chambers, exhaust, fuel and air ports. Steel bottom layer, turned up and overlapping copper top layer at combustion openings, gives strong protection against breakdown and blowout. Copper top, turned down and overlapping steel layer, protects against corrosion.

B → **VICTOPRENE** insert, bonded to steel bottom layer, with overlap on openings, provides tight sealing of coolant chambers. Victoprene was selected for its lowest compression set values.

C → **Shim stop of brass,** riveted to bottom steel layer, prevents excessive compression on Victoprene insert.

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Aetna

A reliable source for precision parts

Precision parts production for Original Equipment Manufacturers has been an important activity at AETNA for almost half a century.

The same precision manufacturing equipment and complete heat treating facilities which produce the exceedingly fine tolerances and accurate finishes required in anti-friction bearings have likewise been employed in the production of a wide variety of other precision parts. Manufacturers quickly learned that they could depend upon AETNA not only to produce these parts but to meet their delivery schedules as specified, and usually at a lower cost than they could be fabricated in their own plants.

These are the facilities for precision parts production that AETNA has available:

Complete, stream-lined equipment for fabricating regular and stainless steel, cast-iron, bronze, brass and Monel Metal in all forms—flats, tubing, forgings, castings, coil strip, coil wire and screw machine bar stock.

Punch press operations to 415 tons pressure-capacity.

Turning, boring and face machining operations to 38" O.D.

Heat-treating, hardening, quenching or chilling treatment.

O.D. bore, face and race grinding to 36" O.D.

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Plating or black oxide surface conditioning.

Tolerances to standard, precision, or super-precision limits.

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Inspection Equipment: Rockwell Hardness Tester; Comparator, Optical Flat and Magnaflux Tests.

Call your local AETNA representative listed in the yellow pages of your Classified Telephone Book, or write direct.

DATA REQUIRED: blueprint, dimensional specifications; special characteristics; load, speed and life requirements, if applicable; quantity requirements; deliveries in terms of estimated initial, monthly and annual production usage.

AETNA BALL AND ROLLER BEARING COMPANY

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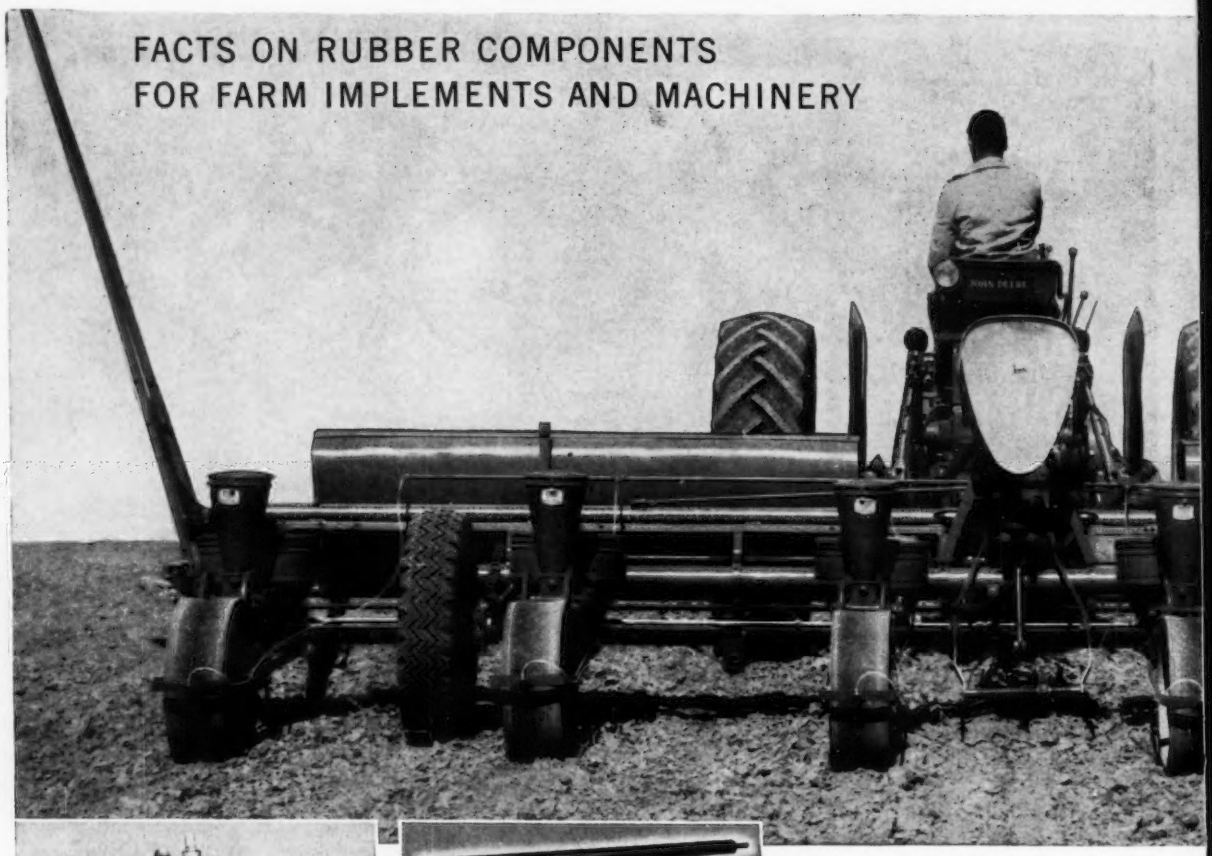
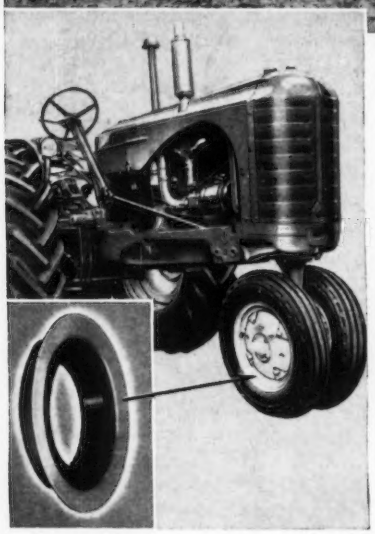
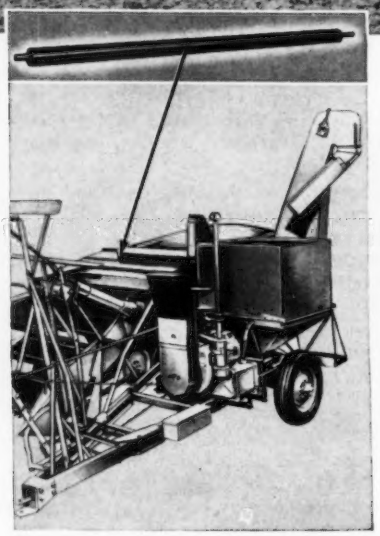
ANTI-FRICTION SUPPLIERS TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916

FACTS ON RUBBER COMPONENTS FOR FARM IMPLEMENTS AND MACHINERY





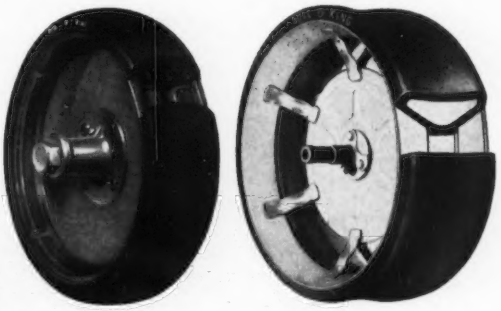
"Orcotite" Dust Seals, developed especially for farm equipment, protect wheel bearings from dust, dirt and grit. The cushion-seal, bonded-to-metal cap adjusts itself automatically for excessive wear and end play.



Draper Apron Roller, still another rubber bonded-to-metal application designed specifically for farm equipment, prevents slippage of the draper apron used for carrying grain from the sickle platform to beaters.

Cylinder Bar is a rubber bonded-to-metal component used in the threshing mechanism of a modern combine. The rubber-faced, steel cylinder bar operates in connection with a rubber stripping plate and two stationary block concaves. Hard and soft shell crops are protected against damage due to excessive crushing.

JOHN DEERE 694 SIX-ROW CORN PLANTER



For gauge wheels *For press wheels*

"Soil King" Tires are designed for more efficient operation under almost any soil conditions–moist, wet or dry. Being semi-pneumatic they are self-cleaning through a flexing action which sheds mud and prevents build-up to maintain uniform working depth. Specially designed seed-press tires press the seed into the soil bed, while press-wheel tires compact the soil over and around the seed, for faster seed germination and crop emergence.

How Ohio Rubber CUSTOMEERING* builds extra value into farming equipment

Every one of the rubber components described here – most of them custom-made by ORCO for leading original equipment manufacturers of farm implements and machinery–added important extra performance and sales advantages to the equipment of which they became a part.

Ohio Rubber engineers, working closely with manufacturers, are able to focus ORCO's broad facilities and experience for the most advantageous solution of virtually any rubber component requirement–silicone rubber, polyurethane or flexible vinyl, whether it involves molding, extruding or bonding to metal.

The forming of "idea" parts for cotton pickers, hay balers, planters, crawler tractors and other farm machinery and equipment, has long been routine at Ohio Rubber. So has the forming of existing components for improved performance. Check Ohio Rubber CUSTOMEERING and see for yourself how it can go to work for *your* greatest product advantage. (9AG 1)

**A Trade Mark of The Ohio Rubber Company*

MORE INFORMATION ON RUBBER

ORCO's 16-page "Soil King" booklet (Form 429) tells the complete story on tires for agricultural service. Get your free copy of it as well as descriptive folder "ORCO Component CUSTOMEERING" (Form 715) on Ohio Rubber's complete facilities and services for forming rubber.

ORCO

THE OHIO RUBBER COMPANY

WILLOUGHBY, OHIO

A DIVISION OF THE EAGLE-PICHER COMPANY

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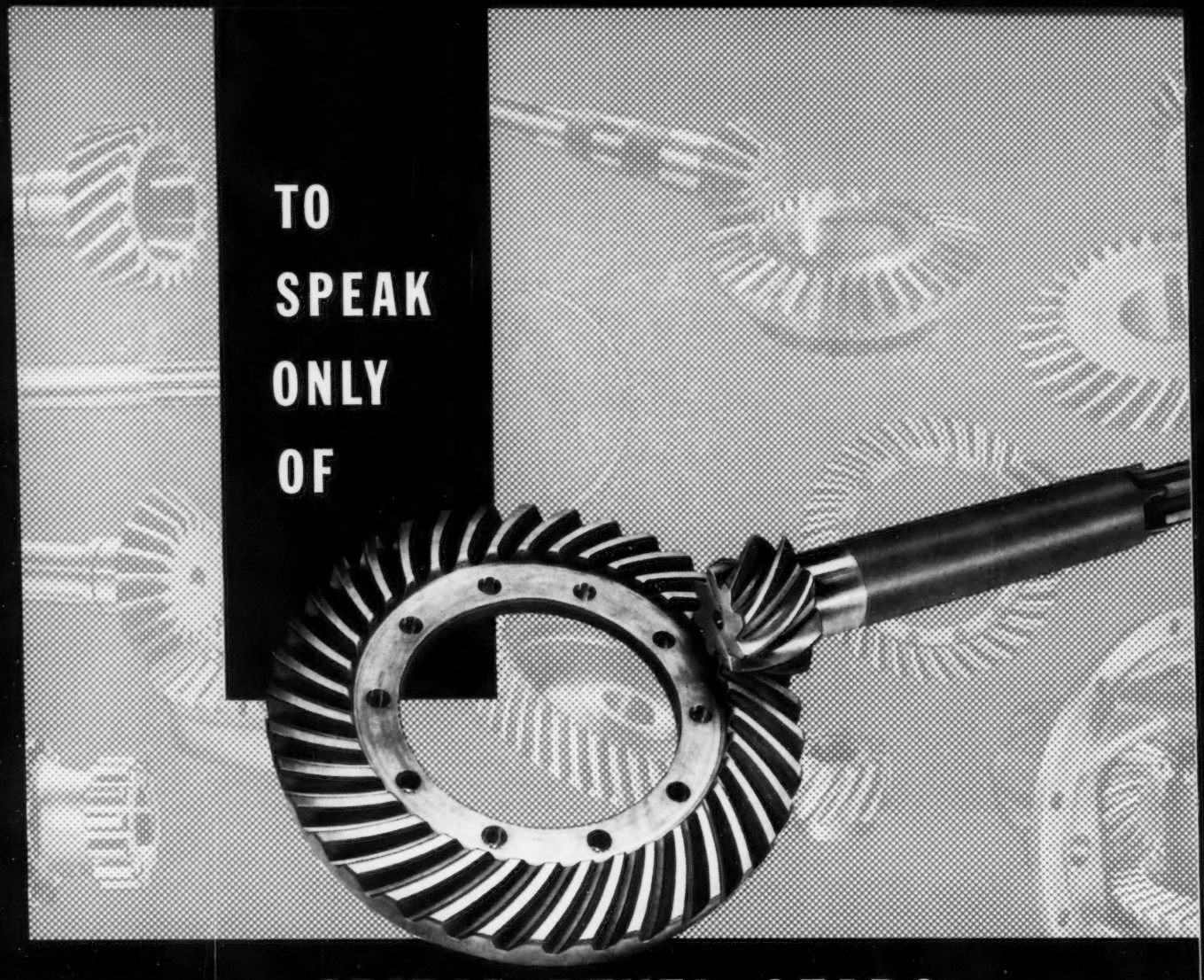


SPIRAL BEVEL GEARS

Spiral bevels comprise just one of the ten gear types in which we specialize, but, speaking of them alone, we have been active in their manufacture since their wide-spread acceptance around 1920. Thus, our experience covers the entire history of this versatile and useful gear type. We were among the first to use lapping on a production basis and to emphasize the importance of lapped and mated gear sets. Automotive Gear was one of the pioneers in developing and promoting the use of special fixtures to eliminate, as much as possible, the chance of human error, and in this way furthered the progress and practicality of spiral bevel installations. Engineering aid in the design of these fixtures for any application is always available to spiral bevel customers . . . as is aid in any area where our specialized gear experience may prove useful. Our gear engineers are available for consultation. Just write!

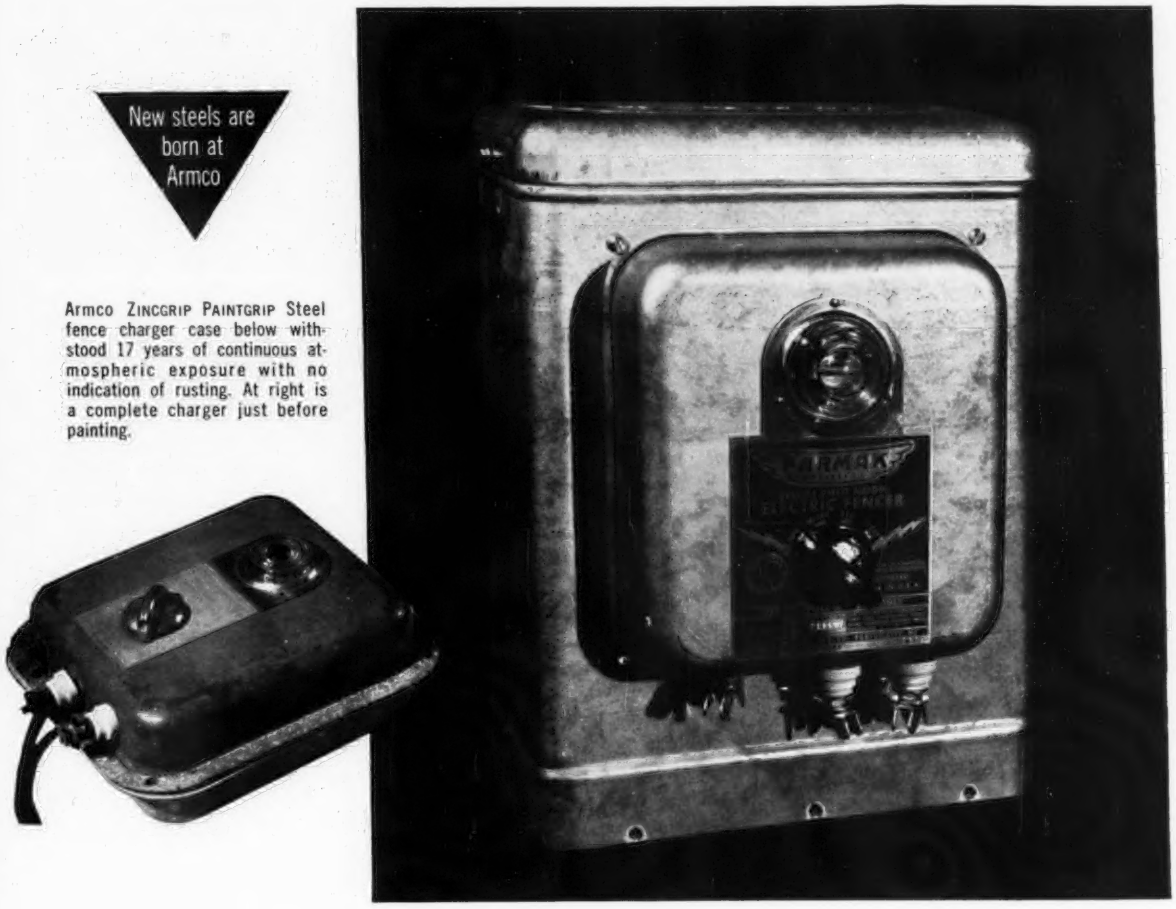
EATON

AUTOMOTIVE GEAR DIVISION
MANUFACTURING COMPANY
RICHMOND, INDIANA

GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

New steels are born at Armco

Armco ZINCGRIP PAINTGRIP Steel fence charger case below withstood 17 years of continuous atmospheric exposure with no indication of rusting. At right is a complete charger just before painting.



Still No Rust After 17 Years' Continuous Exposure

The fence charger shown at left was in continuous outdoor service in a midwestern rural area more than 17 years, yet the Armco ZINCGRIP® PAINTGRIP® Steel case still shows no indication of rusting. Dark splotches are what's left of the original paint that finally weathered away after many years' exposure to sun and rain.

"This is typical of the service life these cases are providing our customers," says an official of the Parker-McCrory Manufacturing Company, Kansas City, Missouri. The company used its first ZINCGRIP PAINTGRIP back in 1940, and has since standardized on this special steel for its complete line of fence chargers.

EASY TO FABRICATE

"Our charger cases require a deep draw, but we've never had any trouble with flaking or peeling of the zinc coating," this official pointed out. "Nor do we have problems of paint flaking or peeling, either, even though we apply it immediately without any special surface preparation in our plant." (ZINCGRIP PAINTGRIP is specially prepared for painting before it leaves the mill.)

For tops in zinc protection plus a surface that is ready for immediate painting with assurance of good paint adherence, it will pay you to consider Armco ZINCGRIP PAINTGRIP Steel for *your* products. If you would like to know all about this special steel, just check the appropriate number on the reader information service reply card in this issue. Armco Steel Corporation, 1809 Curtis Street, Middletown, Ohio.

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Report to Readers . . .

ROLLER PLOW TRANSFORMS SLIDING FRICTION INTO ROLLING FRICTION

A new Hungarian roller plow, claimed to give triple the performance of the conventional moldboard type, is reported by a British contemporary("Farm Implement and Machinery Review"). A V-shaped roller functions like the conventional moldboard and has the same effect as the latter, that is, in turning, mixing, and breaking down the furrow slice. The difference is that rolling friction replaces sliding friction, thereby requiring less power. A second feature of this plow is a slightly V-shaped, almost horizontal roller which rolls on the lower part of the furrow sidewall thus reducing landside friction. . . . . A further power saving results from the combined effect of the two features mentioned, in that the line of draft is at a substantially lower level than is the case with conventional plows, and thus excessive pressure of furrow and land wheels on the ground is avoided. The forces developed in plowing are therefore more in balance, and, as a consequence, the strain on the plow beam is reduced. The tractive effort required is consequently less. . . . . Soil displaced with this plow is said to be evenly dispersed by the spinning of the rollers, thereby leaving the surface substantially level and free of furrows. . . . . It is claimed that this invention can be adapted to existing moldboard plows, also that plowing speeds up to 6 to 10 mph are possible.

HARVESTING TOMATOES BY MACHINE MAY BE CLOSE TO A BREAKTHROUGH

Ag experiment station researchers are taking a hard look at the possibilities of mechanizing the harvesting of the tomato crop. . . . . One of the main handicaps to be surmounted in this quest is the uneven ripening of the crop. This phase of the problem is getting the attention of two Purdue AES plant breeders. They have now developed a dwarf-vined tomato that produces full-size fruit on vines only 12 to 16 inches tall and that can be easily picked mechanically. Their next attempt will be to breed uniform ripening into this variety. . . . . Then the agricultural engineers can really take over. Michigan AES researchers now have an experimental once-over mechanical harvester which they say can pick a tomato vine in 3 seconds. A digger blade on this machine cuts off the vine which is carried back to a shaker bed where the tomatoes are shaken off and the vines dropped to the ground. Improvements in the machine provide for a belt conveyor to lift the tomatoes onto a platform for packing in baskets as the machine moves along the row. While the once-over harvest will not produce as high yields as the usual multiple-harvest system, the researchers contend that lower labor costs will more than compensate for the loss in yields.

HAY CONDITIONER USES RUBBER ROLLS TO REDUCE CURING TIME

The advantage of minimizing leaf loss and thereby increasing the palatability and feeding value of forage is claimed for one of the new hay conditioners. The machine uses fabric-impregnated rubber rolls to crush grass in the swath or windrow, which is said to reduce the curing time, under favorable conditions, by as much as 50 percent. The rolls have spiral grooves which make it possible to pick up hay directly from the swath or windrow without the use of a separate pickup. This conditioner is provided with an hydraulic lift by which the rolls can be separated as the machine is raised to maximum height, which permits the rolls to be cleared easily. . . . . The tension on the crushing rolls is adjustable so that overcrushing of the leaves can be avoided. The rolls are crowned in the center to assure even crushing pressure throughout their length, and the natural qualities of the rubber tend to hold noise and vibration to a minimum. . . . . The big advantage, to farmers, of such a machine is that it enables them to "beat the weather" and to put up the more nutritious hay obtained from early cuttings. Michigan farm management specialists consider the dry matter preserved from an acre of alfalfa to be increased from 68 to 78 percent for hay crushed before baling.

(Continued on page 252)

Design SAFETY into your Drive Lines.

NEAPCO
Shielded Drive Assembly

NEW DESIGN FEATURES WIDER APPLICATIONS

- **Easy disassembly for cleaning, greasing, maintenance.**
- **Available in light and heavy duty series.**
  (1500–1600 Light Duty Series, 1800 Heavy Duty Series.)
- **Designed and manufactured to your specifications.**
- **Provides maximum performance and safety protection.**

Your best source for a complete range of P.T.O. requirements.

SINGLE JOINTS

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END YOKES—complete range of bore sizes.

Standard Round

Short Round

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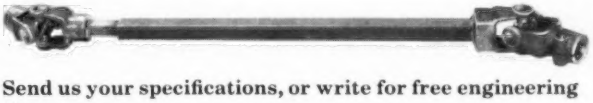
Drive Assemblies to your specifications.
Single Joints and End Yokes in a complete range of sizes.

Neapco is a well known source, with over 35 years of engineering and manufacturing experience . . . able to fill most any drive line and universal joint design requirement you have. Neapco P.T.O. Drives are rugged, precision built for all types of duty. They are supplied with plain or needle bearing journal crosses in a wide variety of yoke combinations. Used as standard equipment for many leading manufacturers in the Agricultural and Truck field.



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NEAPCO PRODUCTS INC.,
POTTSTOWN, PA.

NEAPCO

. . . Report to Readers *(Continued from page 250)*

PLOWSHARES OF STAINLESS STEEL PRODUCE SIGNIFICANT RESULTS

A commercial metallurgical research laboratory, reports a contemporary ("Farm Journal"), has been investigating the feasibility of stainless steel for plowshares. The advantages of stainless steel for this purpose are that it stays sharp, will not rust, and scours well. In fact, it is claimed to meet these requirements so well that engineers have found it possible to redesign and thicken the share point to give longer wear. One farmer is said to have reported that stainless steel shares on a three-bottom plow outlasted two sets of regular shares and were outwearing a third.

MINIMUM TILLAGE REDUCES WORK BUT NEED NOT REDUCE YIELDS

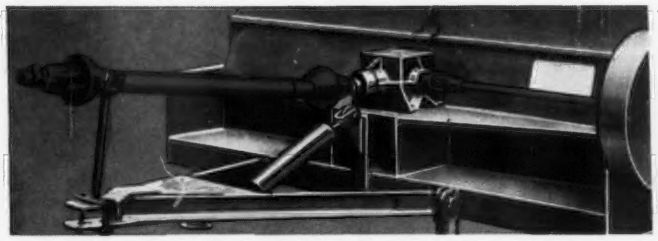
That, in a few words, sums up the conclusions reached by a research team of Illinois AES agronomists and agricultural engineers based on field results over the past six years. The equipment used in these studies included a one-row plow-plant machine developed for the purpose. Among the methods used was wheel-track planting and plowing followed by planting with conventional equipment. . . . . Plant populations obtained with minimum tillage in fifty comparisons averaged 95 percent of those obtained with conventional tillage, while yields were almost identical. In all cases, yields from minimum tillage matched those from conventional tillage on soils with good tilth. . . . . One of several observations from these studies is that plant population is the most important single factor in obtaining maximum yields. Adequate population can be assured by producing a good seedbed in the row and by planting 1/2 to 1 inch deeper than normally.

DUAL TRACTOR CONTROL FOR PEAK POWER NEEDS

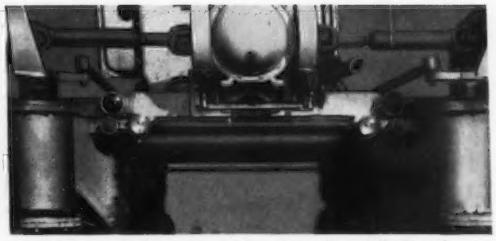
In the main, farming operations requiring tractive power can be satisfactorily performed by small to medium-sized tractors. Often the need arises for power capacity greater than tractors in the lower power ranges can supply, but this may not be sufficient to warrant purchase of a large tractor. To supply these peak power requirements, agricultural engineers in some of the state ag colleges have devoted considerable study to using two tractors in tandem equipped for dual control. . . . . A Purdue engineer has devised a method of controlling the throttle and foot clutch of a trailing tractor with a single hydraulic ram. This permits the operator to control both tractors from the seat of the lead tractor without turning or reaching for any lever or knob. . . . . The principal costs involved in using tractors in tandem are for larger implements and hydraulic hose. Two tractors of any make or model can be operated by dual control, and they do not need to be operated in exactly the same gear or throttle setting. When operated with a power take-off machine, the lead tractor does the pulling, while the other drives the power take-off. . . . . The disadvantages attendant on the use of tractors operated in tandem are such, however, that the practice is not likely to be adopted by a large percentage of farmers.

NEW SLIDING-DOOR SYSTEM OBVIATES MULTILEAF DOOR STORAGE PROBLEMS

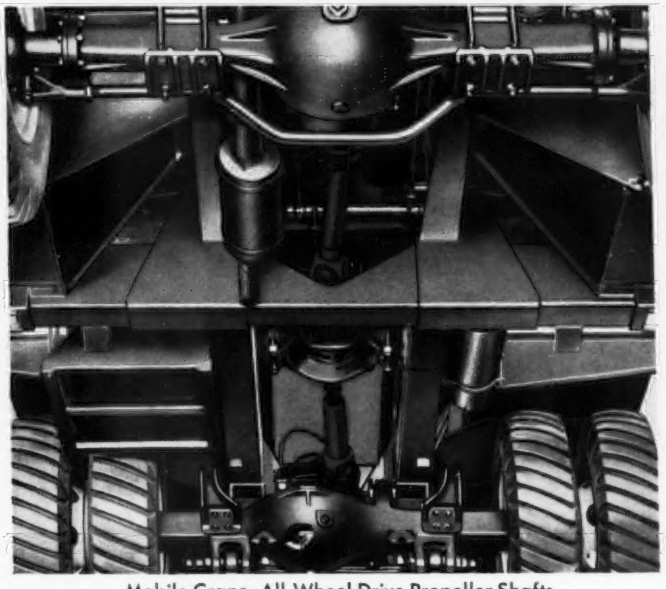
It is not uncommon for a multileaf sliding-door system to present a difficult problem of storage of the connected door leaves, especially on wide openings. A building products manufacturer claims, however, to have overcome this difficulty in a new development recently announced. . . . . The development actually includes two sliding-door systems. A round-the-corner system permits connected door leaves to be rolled around corners (on either inside or outside walls, and on 30, 60, and 90-degree curves) and stored flat along unused walls. (Moving connected door leaves around corners without binding is made possible by a slotted bottom hinge between articulated door panels.) The other, a leaf-stacker system, can be used by itself or in combination with the round-the-corner system. Both systems operate on a single run of track which permits moving almost any combination or number of doors out of the way into a compact space.



Shielded Farm Implement Drive, Tractor P.T.O. to Gear Box

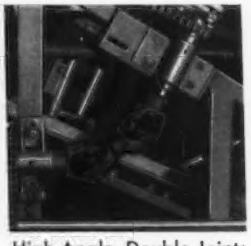


Differential to Drive Sprocket, Straddle Truck

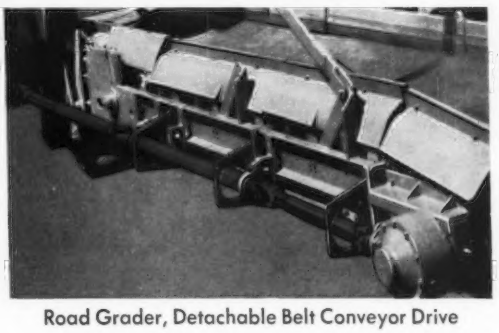


Mobile Crane, All-Wheel Drive Propeller Shafts

Jointed Front-Driving Axle



High Angle, Double Joints



Road Grader, Detachable Belt Conveyor Drive

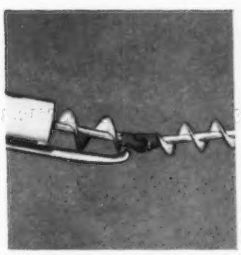
POWER TRANSMISSION PROBLEMS SOLVED

with Blood Brothers U-Joints

Rockwell-Standard engineers see—and help *solve*—a tremendous variety of problems involving a need for universal joints. Applications range from manual steering assemblies...to power take-off drives...to heavy duty propeller shafts.

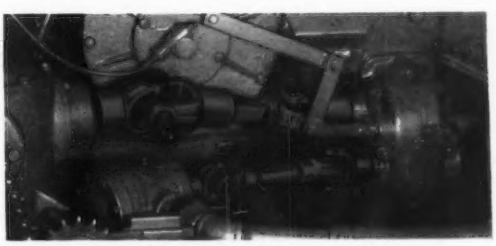
To "get the power through," Blood Brothers Joints are built in the widest range of types and sizes. This range, plus application experience, can be valuable to you. Whether you want to "take power around corners"...or allow for possible minor misalignments—you can call on Rockwell-Standard engineers.

They'll cooperate to save your staff's time—on common or unusual power transmission problems.



Jointed Screw Conveyor

Tractor Steering Assembly



Transmission P.T.O. Drives Pump and Gear Box

ROCKWELL-STANDARD CORPORATION

Blood Brothers Universal Joints

ALLEGAN, MICHIGAN

For general information, request our Bulletin 557

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With JOHN DEERE Haying Equipment

You're Always "On the Sunny Side of the Street"

Bale Ejector Attachment for all John Deere Twine-Tie Balers eliminates the drudgery of lifting and stacking bales—cuts baling and loading to a one-man crew. More important, it cuts costs of operation . . . speeds work . . . brings better hay to storage.

It's another John Deere first . . . another reason why more and more farmers look to John Deere as their guide to progressive farming methods.

Always at least one step ahead in research, design, engineering, and production methods (more often three or four steps ahead)—John Deere makes busy hay seasons much more pleasant and profitable for dealers and their farmer-customers.

Benefits Aplenty

For dealers, there are always advanced machines that are easier to sell and service—machines built in the tradition of John Deere quality. For farmers, there are even more benefits—modern equipment to speed operations . . . quality hay-making methods at low cost . . . dependability to get jobs done while weather permits. For one and all, making hay with John Deere is like walking "on the sunny side of the street."

Better Every Step of the Way

Where else can you find a hay line to compare? Mowers, hay conditioner, rakes, balers, bale ejector, elevators, and barn bale conveyor—they're all built to do a better job, faster with reduced costs. Is it any wonder that the John Deere franchise is the most valued in the industry?

Mowing and conditioning hay costs less in one operation.

Big-capacity, high-speed raking with gentle handling saves leaves.

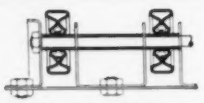
Storing baled hay automatically adds up to even greater savings. One man with the John Deere Bale-Sized Portable Elevator and the Barn Bale Conveyor handles the complete job without heavy lifting.

Conventional baling goes faster, easier in all conditions.

JOHN DEERE
MOLINE, ILLINOIS

"Wherever Crops Grow, There's a Growing Demand for John Deere Farm Equipment"

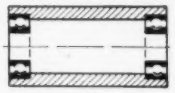
F-M Spacers Save Money in Hundreds of Applications. Spacers shown in Red



Cross member dividers on conveyor sections.

Motor mount bolt sleeve spacer.

Control rod spacers.



Before and after: Two spacers replace undercut machined wheel hub

Leaf spring bolt spacer.

Spacer-stabilizer linkage.

SAVE

Time, Money, Materials with Rolled, Split SPACER TUBES

Spacers can effect savings in many manufacturing and assembly operations—from automobiles to pull toys, phonographs to corn pickers. Furnished to your exact dimensions, ready to assemble, they are an economical substitute for iron pipe, tubing or machined parts; eliminate costly cut-off and de-burring machine time; save on secondary operations such as slots, holes, notches and chamfers. In steel, aluminum and stainless. Plain or plated. Many lengths, diameters and wall thicknesses. Complete engineering service.

FREE design data book on standard and special spacer specifications. Address:

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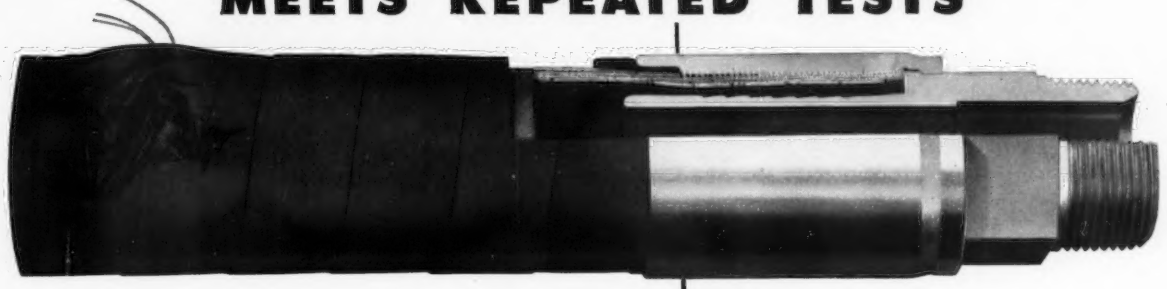
RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

Eastman APPLICATION MEETS REPEATED TESTS



Tests prove that Eastman couplings applied to super high pressure 4-ply spiral wire hose assure successful assemblies. Couplings hold well above minimum burst pressure.

PERMANENTLY ATTACHED COUPLINGS PROVIDE BOND STRONGER THAN HOSE ITSELF!

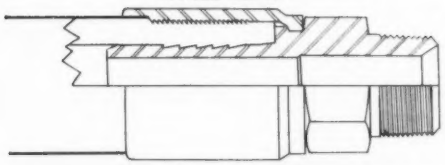
Increasing demand for greater power brought about the use of higher pressures in hydraulic systems. This not only calls for greater hose strength, but far more critical engineering in coupling design and application.

EASTMAN is contributing toward the development of the trend toward higher pressures—not only in the design and application of coupling to hose—but in the more exhaustive tests required to assure adequate safety under high pressure operations.

The actual photo above is typical of many tests in Eastman laboratories proving that the hose did not fail at the coupling—demonstrating that the coupling was designed and applied to form *a bond which was stronger than the hose itself.*

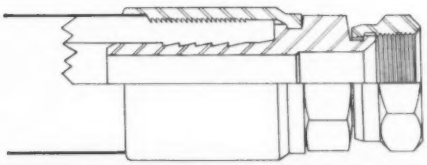
If you have an application requiring higher pressures, let our engineering department demonstrate the superiority and economy of Eastman applications, and quote on complete Hydraulic Hose Assemblies.

MALE NPTF



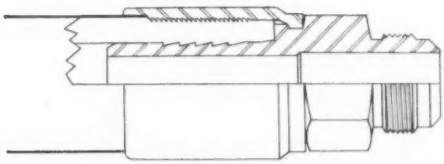
Catalog No.	Hose I.D.	Hose O.D.	Coupling I.D.	Min. Burst Pressure (P.S.I.)	Max. Wkg. Pressure (P.S.I.)
	(inches)				
8412-12M	¾	1 7/16	19/32	20,000	5,000
8416-16M	1	1 ¾	25/32	16,000	4,000
8420-20M	1 ¼	2	1 3/64	12,000	3,000
8424-24M	1 ½	2 ¼	1 21/64	10,000	2,500

SWIVEL FEMALE JIC-37°



Catalog No.	Hose I.D.	Hose O.D.	Coupling I.D.	Min. Burst Pressure (P.S.I.)	Max. Wkg. Pressure (P.S.I.)
	(inches)				
8412-12FH	¾	1 7/16	19/32	20,000	5,000
8416-16FH	1	1 ¾	25/32	16,000	4,000
8420-20FH	1 ¼	2	1 3/64	12,000	3,000
8424-24FH	1 ½	2 ¼	1 21/64	10,000	2,500

MALE JIC-37°



Catalog No.	Hose I.D.	Hose O.D.	Coupling I.D.	Min. Burst Pressure (P.S.I.)	Max. Wkg. Pressure (P.S.I.)
	(inches)				
8412-12MH	¾	1 7/16	19/32	20,000	5,000
8416-16MH	1	1 ¾	25/32	16,000	4,000
8420-20MH	1 ¼	2	1 3/64	12,000	3,000
8424-24MH	1 ½	2 ¼	1 21/64	10,000	2,500

Eastman *first in the field*

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WRITE today for your copies—

Technical Bulletin 100—Medium Pressure Hose and Tube Assemblies, Couplings and Fittings for One Wire Braid Hose.

Technical Bulletin 200—High Pressure Hose and Tube Assemblies, Couplings and Fittings for Multiple Wire Braid Hose.

Rolling "service station" saves field work delays!

In 1928, Bill Weaver, of Lamesa, Texas, started farming on 25 acres he rented from his father. Today, he operates the entire 6,500-acre farm, 4,000 of it in cotton.

The home-made "service-station on wheels" shown here serves his 14 tractors in the field to save time in fueling and lubricating the equipment. Air is pumped into the gasoline tank to provide nozzle pressure.

Other equipment on the farm includes 62 trailers, a motor grader, big sub-soiler plows and dozens of trucks.

Standing with Mr. Weaver (left) is Texaco Consignee Tom Conner, who supplies Havoline Motor Oil, Fire Chief gasoline and other Texaco products for the equipment. That's Farm Service Representative Roy Page servicing the "service station." Mr. Weaver, like other progressive farmers and ranchers the country over, has found *it pays to farm with Texaco products.*

Another inventive farmer!

Here is the farm-made hydraulic dump truck built by Harry Geogline (right) who farms 260 acres near Wayne, Ohio. The pump and truck axles he bought at a junk yard. Gerald Stahl (left) and his father, Texaco Distributor C. J. Stahl, supply Texaco Marfak lubricant and other Texaco products to Mr. Geogline.

Mr. Geogline prefers Marfak because it won't drip out, wash out, dry out, or cake up—forms a collar around open bearings, sealing out dirt and moisture. He, too, finds that *it pays to farm with Texaco products.*

THE TEXAS COMPANY

BUY THE BEST...BUY TEXACO

DENISTON "LEAD-SEAL"

Metal Roofing Nails

Designed to do a Special Job

No one type of nail is good for all types of duty. That's why DENISTON designed a nail especially for use in applying metal roofing. One that would give a seal through which no moisture can penetrate.

DENISTON "Lead-Seal" galvanized finish metal roofing nails have proven their efficiency because of these advantages—"lead-seal", triple-lock, drive screw shank and heavily zinc-coated for protection against rust. With this combination you get a nail that will easily last the lifetime of a roof. *To insure superior quality, DENISTON "Lead Seal" nails are now available in galvanized finish only.*

LEAD SEAL—Lead is under the head and down the shank. When the nail is driven, the hole around the nail is plugged with lead and the break in the metal is completely covered, to form a perfect double seal.

TRIPLE-LOCK—As the "bump" is forced through the sheet, the sheet springs back over the bump—this effectively prevents the nail from working out. The nail, lead and sheet are solidly locked together.

DRIVE SCREW SHANK . . . makes the nail turn and hold like a screw. It holds with a powerful, un-yielding grip. Threads are deep and sharp because they are formed after galvanizing.

DENCO Lead-Head Metal Roofing Nails

Nail Head is Completely Covered with Lead

6,000 pounds of pressure is used to compress the lead *cold*, both *over* and *under* the steel head of the nail as well as *down the shank*. This insures a tight head that is impossible to knock off when driving the nail. In addition, the lead forms a perfect seal in the hole made by the nail. The heads will not "pop" off from the expansion and contraction of the metal roofing nor from wind vibration.

All DENISTON nails are shipped in 50 lb. sturdy 3-ply corrugated color-board cartons. Descriptive literature on Deniston "Lead-Seal" and Denco Lead-Head nails will be sent immediately upon request.

32 Years of Quality Nails

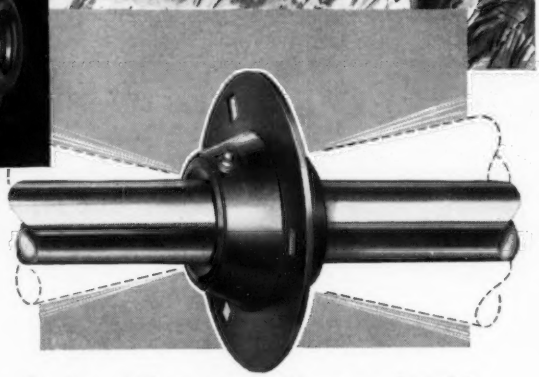
THE DENISTON COMPANY

4876 South Western Avenue • Chicago 9, Illinois

IN CANADA: EASTERN STEEL PRODUCTS CO., LTD., PRESTON, ONTARIO

DENISTON Lead-head ROOFING NAILS TRADE MARK

Adjusts to axial misalignment —when going is rough



ROLLWAY FLEXI-FLANGE® BEARING

with neoprene housing and Buna seal

A rugged unit of versatile application, the Rollway Flexi-Flange readily adjusts to angular shaft displacements caused by rough terrain. Engineered to the service demands, life-expectancy and storage requirements of most implements, the cost is well within the salable limits of implement pricing.

Flexible Neoprene Housing

Permanently bonded to the flange, the flexible neoprene housing permits wide-angle shaft displacement and assures bearing parallelism under all conditions of load and stress. Life of the long-line rollers and races is surprisingly lengthened by this design. There is a corresponding reduction of fatigue on the shaft on which the rollers operate.

Resists Oil, Grease, Heat and Cold

Exhaustive tests and field usage have conclusively proved the durability of the neoprene housing and Buna seal. It retains its life and resilience after long use and repeated exposure to oil, grease and extremes of heat and cold.

Easy to Install

The self-contained Flexi-Flange unit is easily installed . . . saves assembly time . . . lasts for the normal life of your implement.
WRITE or wire for descriptive bulletin or free engineering consultation on your application problems.

ROLLWAY BEARINGS

ROLLWAY BEARING CO., INC. 541 SEYMOUR STREET, SYRACUSE 1, N.Y.

ENGINEERING OFFICES

SYRACUSE, BOSTON, CHICAGO, DETROIT, TORONTO, PITTSBURGH, CLEVELAND, SEATTLE, HOUSTON, PHILADELPHIA, LOS ANGELES, SAN FRANCISCO

NATIONAL OIL SEAL LOGBOOK

Oil Seal Selector Chart

The data given below indicate, for most common applications, the type of oil seal that will operate best under given conditions. Where one or more parameters are extreme, modified or special seals may be required. For engineering help or availability details, call the nearest National Seal Engineer. Look under Oil Seals, in the Yellow Pages.

50,000 series
Micro-Torc
Leather

450,000 series
Syntech
Synthetic

410,000 series
Syntech
Synthetic

MATERIAL SEALED	Mineral base oils and greases are most common materials. Availability of lubricant, criticalness of service, and cleanliness strongly influence construction choice. National Micro-Torc leather seals are recommended for grease and oil applications and particularly where semi-starved lubricant conditions may exist. For oil and fluid "zero leakage" service Syntech seals are normally considered. For applications involving both "zero leakage" and heavy dirt conditions, the user may wish to consider dual lip Syntech seals.			
SHAFT SPEED	Prime factor in seal selection. Governs all other factors. Shown in FEET PER MINUTE AS SLOW, MODERATE, HIGH.			
FPM	Slow	0 to 800	0 to 1000	0 to 1000
	Moderate	800 to 1500	1000 to 2000	1000 to 2000
	High	1500 to 2000	2000 to 3000	2000 to 3000
TEMPERATURE	Limits shown are points where sealing material or medium sealed becomes ineffective. For sealing under extreme temperature conditions, special compounds can be employed.			
LIMITS °F.	Continuous	−65° +200°	−65° +225°	−65° +225°
	Intermittent	−65° +225°	−60° +250°	−60° +250°
PRESSURE	Conventional oil seals are not pressure seals. Where pressures above those shown exist, special seals should be employed or pressure against sealing lip relieved.			
MAXIMUM PSI	Slow	15	10	10
	Moderate	10	7	7
	High	5	5	5
SHAFT FINISH	Fineness and type of finish, direction and spiral of finishing marks and leads as well as RMS value affect sealing. Polished or ground finishes with concentric finish marks are preferred.			
MAXIMUM MICRO INCHES	Slow	25	25	25
	Moderate	20	20	20
	High	20	20	20
SHAFT HARDNESS	Although shafts as soft as cold rolled steel can be sealed successfully, hardness of C20 Rockwell or greater is preferred. Fluid starvation, abrasives and high surface speeds require hard shafts.			
SUGGESTED ROCKWELL	Abrasives	above C-45	above C-45	above C-45
	No abrasives	above B-80	above B-80	above B-80
SHAFT TO BORE MISALIGNMENT	Fixed misalignment of center of shaft rotation with bore center. Concentrates wear at one side of seal. Becomes more severe as speed increases.			
TOTAL INDICATOR	Slow	.010	.015	.015
	Moderate	.005	.010	.010
	High	.005	.010	.010
SHAFT RUN-OUT	Oscillating non-concentricity between shaft and bore centers (also eccentricity or shaft whip). Run-out should be kept to absolute minimum; creates difficult sealing problem.			
TOTAL INDICATOR R P M	0-800	.010	.025	.025
	800-2200	.005	.020	.020
	2200-4200	.003	.015	.015

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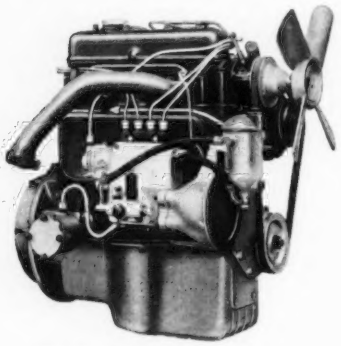

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Agricultural Engineering

May 1959
Number 5
Volume 40

James Basselman, *Editor*

Engineering Defined

ACCORDING to an announcement in the March issue of the *Journal of Engineering Education*, the Recognition Committee of the Engineers' Council for Professional Development (ECPD) has completed its first step toward formulating a definition of engineering. At its 26th Annual Meeting ECPD voted "to adopt a tentative definition (as submitted by the Recognition Committee and given below) for dissemination." It is reported that comments are solicited and should be sent to G. H. O'Sullivan, J. L. White Engineering Corp., 80 Broad St., New York 4, N. Y.

"Engineering is the Profession in which a knowledge of the mathematical and physical sciences gained by study, experience and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the progressive well-being of mankind."

Explanations:

1. Engineering is defined as a profession – thereby grouping it with the other so-called learned group in the community, such as medicine and law.

2. The idea of knowledge is included in the definition because it is felt that it is knowledge that distinguishes a profession and that it is knowledge which the professional applies in the accomplishment of his objective.

3. The scope of the knowledge peculiar to engineering has been limited to the realms of the mathematical and physical sciences to distinguish from medical or psychological sciences, for example. The physical sciences include such items as chemistry, electronics, strength of materials, biology, geology, etc.

4. Study, experience, and practice are enumerated because these are the items by which an engineer is judged and which he must, in fact, prove if he is to be accepted by any legal jurisdiction.

5. The idea of judgment is included in the definition in part to comply with the suggestions which a number of critics have offered, namely, that economics is a sufficiently important phase of engineering activity to justify its inclusion specifically in the definition. Whether or not a matter is economical is usually a matter of judgment. In addition, many engineering decisions are made in areas not subject to specific and accurate analysis.

6. The words from "to utilize . . ." are extended to convey, first, that economics is a primary consideration in all engineering, and second, that the engineer's tools are the resources of nature and his aim to improve human welfare. Thus these words cover the objectives of the engineer as well as his mode of operation. The use of materials and forces which are new or not well known is not excluded.

Agricultural Tractor Test Code Approved

THE Council of ASAE and the Society's Technical Committee of the Power and Machinery Division recently approved a new ASAE Standard, entitled "Agricultural Tractor Test Code." The new standard also has been approved by the Society of Automotive Engineers as an SAE Standard. Final approval by both organizations completed over two years of work by the SAE Tractor Test Code Committee which had been established to formulate a practical test code to best evaluate the performance of the modern farm tractor. The new standard provides for testing on concrete and takes into consideration increased emphasis that has been placed on the use of the power take-off in farming operations during recent years.

The test code was prepared to help those who are required to secure performance data on agricultural tractors and to certify test results. Its purpose is to define the test conditions, give a description of the tests to be made, specify data to be obtained, show formulas and calculations, define terms, and establish a uniform method of reporting so that performance data obtained on various makes and models of tractors, tested in accordance with the standard, will be comparable regardless of where the test is made.

Since many present day tractor models are available in a number of types with numerous items of special or optional equipment, the scope of the standard is limited to that of obtaining and reporting only the most significant of widely used performance data. The following sections are included: *(a)* test conditions, *(b)* detailed description of test procedure, *(c)* calculations and formulas, *(d)* definition of terms, and *(e)* uniform method of publishing results. Test procedures include limber-up and preparation of tractor for performance runs; mechanical power outlet performance; and drawbar performance. Fuel consumption under maximum power and varying power, and power at ASAE-SAE Standard power take-off speeds are determined under mechanical power outlet performance. Maximum drawbar power with ballast; varying drawbar power-fuel consumption with ballast; drawbar pull vs. travel speed with ballast; maximum drawbar power without ballast; and final inspection are covered under drawbar performance.

Copies of the new standard will be available from ASAE, 420 Main St., St. Joseph, Mich., after June 1 at 50 cents per copy. Quantity prices available upon request.

ASAE 52nd Annual Meeting • Cornell University, Ithaca, N. Y., June 21 - 24

Some Observations on Soil Compaction Tests

A. W. Cooper *Member ASAE*

M. L. Nichols *Life Fellow ASAE*

The effects of implements and traction on the compaction of soil and review of research studies directed toward solution of the problem

MECHANIZATION in agriculture has been a major factor in the advancement of civilization in the twentieth century. However, this rapid development and extensive use of larger power units and equipment has brought, along with its benefits, economic and physical problems of land and soil management which require for their complete solution the combined efforts of many branches of science. While recognizing the importance of management, physical and biological problems, the observations in this paper will be directed primarily toward the effects of implements and traction on soil compaction.

Soil Physical Properties Affecting Plant Growth

Compaction or the increasing of the soil bulk density (weight of soil per unit volume) by the reduction of pore space between the soil particles affects all life within the soil. The changes produced by variations in bulk density or pore space may be very complex. The amount of free pore space (that not filled with water) may be the dominant factor in oxygen and carbon dioxide necessary for plant growth. The diffusion of a gas generally depends on the total free pore space rather than upon the size distribution of the pores. The rate of transmission of water, on the other hand, depends upon the size of the pores or channels and is not alone a function of the total pore space. Compression by traffic and implements may affect both the total porosity and the size of the pores and channels. Baver(1)* points out that, in the relationship of physical properties of soil to plant growth, restricted soil aeration is an important limiting factor in the development of an extensive root system. It impairs the essential process of respiration of an established root system which retards both water and nutrient absorption and prevents the orderly functioning of essential biological processes associated with good soil fertility.

Baver(2) and Middleton(3) show that the total porosity for a number of agriculturally important American soils varies from 30 to 60 percent by volume. The total pore space percentage by volume needed for good plant growth depends upon the physical structure of the soil and the type of crop being grown. Pendleton(4) found good development of sugar beet roots in Willamette silt loam with a total pore space of 62.5 percent and poor root development at 46.5. In Chehalis sandy loam he found good root development at 53.5 percent total pore space and poor root development at 45.5 percent. At a bulk density of 1.95 in either soil no roots penetrated it. Under medium compaction with a bulk density of 1.8, the main taproot usually penetrated through the soil mass but there was very little feeder root development. Bushnell(5) reported that with potatoes in Ohio the threshold at which the compactness of the soil prevented the entrance or survival of potato roots was near the point of 47 percent total pore space.

The non-capillary pores (large pores which will not hold water by capillarity) are largely responsible for air capacity and ready percolation of water. Russell(6) in his review of soil structure indicated that about one-half of the pore space should be non-capillary. Baver and Farnsworth(7) showed that, with 8 to 10 percent non-capillary pore space, a yield of over 12 tons per acre of sugar beets was obtained while, with 6 to 7 percent, the yield was reduced by one-half. At 2 percent non-capillary pore space the yield was a little over 2 tons. They further found that soil which had become compacted by tillage traffic had non-capillary pore space values as low as 2 to 4 percent. Pendleton(4) found feeder root development much better in Chehalis sandy loam at 14 percent non-capillary pore space than at 6.5 percent. All sugar beet root development was restricted at 3.5 percent non-capillary pore space. In Willametter silt loam the sugar beet roots were restricted when the non-capillary pore space was 11.7 percent but grew well at 18 percent.

A simple determination of a range of pore sizes may be made by tension apparatus such as described by Jamison and Reed(8). The pores drained at 60 cm water tension are considered arbitrarily as noncapillary pores by many investigators.

In addition to the possibility of compaction causing poor oxygen diffusion and poor moisture relationships, there is evidence(9) that a soil which has been compressed may cause impedance to roots because of its increased mechanical strength. The roots actually may have to exert more force to penetrate the soil mass. If this condition does exist, Gill and Miller(10) showed that the rate of growth of corn seedling roots drops off rapidly as the pressure encountered by the roots increases. They showed that in order for a root to maintain a constant growth against an increased mechanical resistance more oxygen was required. Therefore, compaction of the soil may reduce plant root development by mechanical impedance and by restriction of oxygen diffusion.

Trouse(11) has made comprehensive field examinations of compaction by tillage and transportation machinery on Hawaiian soil in sugar cane production. He found numerous cases where roots were distorted and showed evidence that they had developed and functioned in a compacted soil

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers in Chicago, December 1956, on a program arranged by the Power and Machinery Division.

*Numbers in parentheses refer to the appended references.

The authors—A. W. COOPER and M. L. NICHOLS—are, respectively, director and former director, USDA National Tillage Machinery Laboratory, Auburn, Ala.

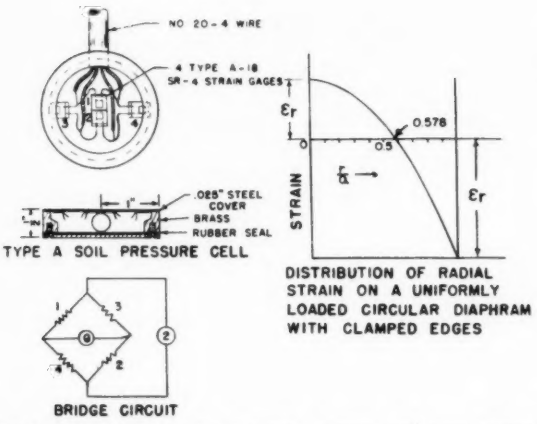

Fig. 1 Modified Type A strain gage pressure cell gives accurate pressure measurements when suspended in a homogenous soil layer

medium. The roots in uncompressed soil were rounded, whereas the roots in the compacted soil were flattened. This flattening of roots was also reported by Gill and Miller(10) in the case of corn seedling roots.

Baver(1) reviews studies which show that compacting soil increases the rate of heat transfer and therefore the temperature of the soil. This effect of compaction may have a beneficial or a detrimental effect on plant growth depending upon soil moisture, weather conditions, and the crop.

Types of Forces Applied to Soils

The kind of force applied to a soil makes a material difference in the amount of force required for a given compaction. The amount of compaction may be materially less for a static or simple direct pressure than for a dynamic force such as that produced by slippage of a tractor tire. Bodman and Rubin(12) have obtained data which show relationships of change in volume per unit work. They found that the reduction of pore space by simple direct pressure was materially increased when puddling occurred. The nature of this puddling effect was shown by McKibben(13) in his study of the soil reaction before a pulled wheel. Gill and Reaves(14) pointed out that compaction results from horizontal forces caused by thrust as well as from vertical forces. This action gives an orientation of particles which may cause more compaction than one simple force. Terzaghi and Peck(15), discussing consolidation such as occurs under traffic or produced under foundations of engines and other vibrating forces, state that vibration may increase the bulk density of a soil and cause its surface to subside. If the frequency of a vibration of a machine supported on a sand is within the critical range for the sand, the resulting settlement is much greater than would be caused by the equivalent static force. The effect of vibrations on clays is far less conspicuous than on sand because the cohesive bond between clay particles interferes with intergranular slippage. Nevertheless, even a soft clay consolidates to a moderate extent when it is subjected to intense vibrations.

Measurement of Pressure Distribution in Soil

A number of cells have been developed to measure pressures in soil under walls, footings, and tunnels. Some of these cells are described in the Waterways Experiment Station report(16). Those described are the Goldbeck cell, Carlson stress meter, Wes soil pressure cell (an electrical resistance strain gage pressure cell) California State Highway Department pressure cell, carbon pile cell, and acoustic stress meter.

There has been a growing interest in the measurement of pressures in surface soil under agricultural equipment in the last few years. Soehne(17) used a hydraulic cell to measure pressures in surface soil. He reported that the cell had to be placed in the soil with extreme care to avoid significant error. Cooper *et al*(18) reported good results with a small strain gage pressure cell (Type A). A modification of the Type A strain gage pressure cell is shown in Fig. 1. Laboratory tests using this cell indicated that it was quite accurate when suspended in a homogeneous soil layer(18). When it is placed on a firm surface and has loose soil above and to the sides of the cell, the pressure indicated by the cell is approximately 25 percent high. With a soil of higher density this error becomes less. The range of error that might be encountered with a very thick cell ranges from a very small error with low pressures and high bulk densities to several hundred percent error with higher applied pressures and lower soil bulk densities(18).

The cell shown in Fig. 1 differs from that described in reference(18) in that it is thinner and the four gages of the bridge are placed on the stainless steel diaphragm instead of having two inactive gages on the sides of the brass box. This modified cell has approximately twice the sensitivity of the original cell and should have better temperature compensating characteristics. As can be seen in Fig. 1, when pressure is applied to the cell, gages 1 and 2 are in tension and 3 and 4 are in compression. VandenBerg *et al*(19) described pressure measurements made under tractor and implement tires using the Type A cell. From calculated loads applied to the soil and measurements of pressure under the center of the tires, these pressures followed the same pattern as values calculated using Frochlich's formula(18). Willits (20) reported relative pressure measurement under various tractor and implement tires and tracks with a strain gage load cell.

Reaves and Nichols(21) describe a method for determining qualitatively the force distribution in soils with a glass fronted box. The inside of the glass was coated with levigated alumina. As a force is applied to the surface of the soil, the movement of particles below the surface can be traced by scratches in the alumina.

Apparatus for measuring the vertical and horizontal load applied to the soil by a track and the pressure distribution in the soil are being developed at the USDA National Tillage Machinery Laboratory. This includes apparatus for the measurement of forces on the soil by an individual track shoe as it contacts the ground, carries the weight, and leaves the ground and pressure cells to determine the distribution of pressure in the soil.

Effect of Pressure on Change in Bulk Density

The measurement of pressure alone gives no indication of the compaction resulting from the pressure. The resulting compaction from a given pressure depends upon the mineralogical and mechanical composition, the moisture content, and the initial consolidation of the soil. However, by sufficient study of the pressure applied to soils, the pressure distribution in the various types of soil under various soil conditions, and the effect of the various pressures on the soils, much progress should be made in determining the im-

plement and tractor design factors needed to minimize soil compaction.

The amount of compression obtained with a given pressure depends in large part upon the moisture content of soil. For example, at the National Tillage Machinery Laboratory, when loose Lloyd clay loam at 15.9 percent moisture was subjected to 30 psi, the resulting bulk density was 1.09, while at 23.6 percent moisture (approximately the lower plastic limit) the same pressure produced a bulk density of 1.24.

Day and Holmgren(22) illustrated the effect of moisture on the state of compaction caused by pressure. In the case of Yolo silty clay loam at 15 percent moisture when subject to 21 psi, the bulk density was 1.07 g per cc (grams per cubic centimeter). The same soil at 25 percent moisture subjected to the same pressure was 1.69 g per cc. When the same soil at 25 percent moisture was subjected to a pressure of 7 psi, a bulk density of 1.23 g per cc was obtained.

The soil in a cultivated field also varies widely in its resistance to compression because of variation in texture and structure. Nichols and Reaves(23) showed that light pressure on newly plowed sandy or loamy soil similar to plowed conditions may produce a collapse of the temporary structure produced by the plow. It is a common observation that even an irrigation or heavy rain may do this. In some heavy clay soils and other cohesive soils when not subjected to heavy traffic, the non-capillary pore space or even channels may exist for years(23).

For a static loading, the pressure required to effect a given increased increment of compression increases logarithmically(21). The amount of compression by a given force is inversely proportional to the amount the soil has already been compressed. The resistance to compaction depends upon the coefficient of internal friction and the structure of the soil.

Soehne(24) states that for shallow soil depths the surface pressure has a decisive effect on the soil, while at greater soil depths the total load, that is, the product of the surface pressure and the surface area, governs the stress distribution. He used semi-empirical formulas of Froehlich, plus laboratory compactibility tests to show the compressive stress under tractor and farm trailer tires. Soehne concluded for his soils that in the region of normal moisture content there exists no danger of a damaging soil compaction for the usual pressures of tractor tires up to 35 psi. If, however, certain soils are to be traveled on while they are still wet, the pressure of the wheels must be considerably below 14 psi. Trouse(11) found that ground pressures as low as 4.5 psi were detrimental to some Hawaiian soils.

McKibben and Green(25) charted the movement of individual particles in a sand under transport wheels. They arranged small beads according to a predetermined color pattern in three dimensions and charted the travel of the particles by determining their location before, intermediate, and after the wheels have passed over the sand. They found that ahead of the wheel and to the side of the track after the wheel has passed there is an increase in cross-sectional area (expansion). Below the wheel tracks there is a decrease in cross-sectional area (compression). They showed also that the particles had a curvilinear motion. Gliemeroth (26) made a more detailed study of the motion of individual soil particles under a wheel and track vehicle by making slow-motion moving pictures of individual particles. He found that under the front and rear wheels of a tractor the path of an individual particle resembles the figure 6. However, the extent of the movement is several times greater in the case of the heavily loaded rear wheel. He observed that as the front wheel approaches, the individual soil particles move slightly upward from their normal position and then dip forward. Such horizontal rotations, he states, within the soil will cause the severing of roots which, much like compression of the soil, is quite harmful. The forward sloping movement then assumes more and more an upright direction. Once the front wheel has passed over the spot, a certain slanted rising behind it will occur. Under a crawler tractor track Gliemeroth found that the soil particles shift virtually downward, as a result of what appears to be a purely static load effect.

Breaking Up Compacted Layers

Interest in subsoiling and chiseling or breaking up compacted layers caused by traffic over fields has increased in recent years. The results from these treatments have been quite varied. In some cases breaking up compacted layers has resulted in phenomenal yield increases, in other cases only slight yield increases have been reported, and in many cases there has been no increase in yield due to subsoiling. It is difficult actually to evaluate the effect of deep-tillage operations. In many tests little has been done to evaluate the soil conditions before and after deep tillage and the lasting effect of the tillage operations. Many times the weather conditions are such that no differences in yield should be expected, such as when rainfall is lacking. This situation is exemplified by the statement of a scientist who, after carefully analyzing an experiment, said, "Well, the only thing that one can conclude from this experiment is that subsoiling does not increase the annual rainfall."

A number of different designs of subsoilers have been tested in the soil bins at the National Tillage Machinery Laboratory. In these tests the main emphasis has been on the differences in draft requirements of the tools under uniform soil conditions. The fracture pattern of the soil has been studied, however, in several ways — among them are examining and photographing the fractured profile, dry sieve analysis, wet sieve analysis, measuring the swell in the soil surface, penetrometer tests, and bulk density determinations.

The way a soil breaks up does not depend on the shape of the implement alone but also depends upon the properties of the soil. In the case of consolidated Decatur clay loam in a well-aggregated condition, the profile examinations and sieve analyses showed essentially the same breakup with several shapes and widths of tools. The draft, however, varied depending upon the width of the point, the lift angle, and the shape of the subsoiler standard.

In addition to the bin tests, studies are being made using models in the laboratory. To date these studies have shown large differences in draft of the straight, 60-deg, and 45-deg chisels, the draft decreasing, respectively. The reaction, as studied with the chisels running close to a glass on the side of a soil box, is very complex. The flat surface moving through soil traps and moves before it a portion of the soil. This soil wedge is a major factor in the resistance of the soil to the motion of the tool because of the internal friction of

soil over soil. The trapped portion is like the keystone of an arch that applies pressure at an angle, thus distributing the pressure over a larger area. This has been shown by Reaves and Nichols(21) who point out that the side movement of force or arch action is extremely important in the distribution of pressure in soil.

Trouse(11) has made outstanding investigations of the problem of breaking up compacted soils for seedbed preparation in sugar cane production in Hawaii. Many of the volcanic soils he is working with have exceptional physical properties. For example, soils are found under normal field conditions with extreme ranges of from 0.3 bulk density and 125 percent moisture to 2.5 bulk density and 40 percent moisture. Trouse observed that after subsoiling and plowing with a disk plow, it was common to find the bulk density of the soil in the subsoiler groove below plowing depth as high as or higher than the original bulk density of the soil before the subsoiling operation. He also observed that harrowing operations after plowing recompacted the soil below the depth of the harrow operation so that the loosening effects of both the subsoiling and plowing were counteracted. This compaction took place under normal field operating conditions. McCreery and Nichols(27) show the mechanics of the forces by disks which result in compaction.

In order to test subsoilers under field conditions, a field dynamometer is being developed. This is comprised of a pair of strain gage draft links (Fig. 2). The draft links are bolted to the tool bar of a Caterpillar tractor. The tools to be tested are bolted onto a tool bar fastened to the other ends of the draft links. Depth wheels are carried on the front tool bar. In this way only the tool being tested is contributing to the load being measured by the draft links. In calibrating the units the strain in the top members and the strain in the bottom members of the draft links will be measured separately. In the first calibration curve the differences in the strains resulting from increment loading on the tool will be plotted against the loads. This difference in strain is constant for a given horizontal load anywhere along the chisel. Then in the second calibration the strain in the top members of the links will be plotted against the product of the load and distance from the bottom members of the links. By this arrangement the horizontal load on a subsoiler can be determined from the first calibration; then the center of load can be determined from the second calibration.

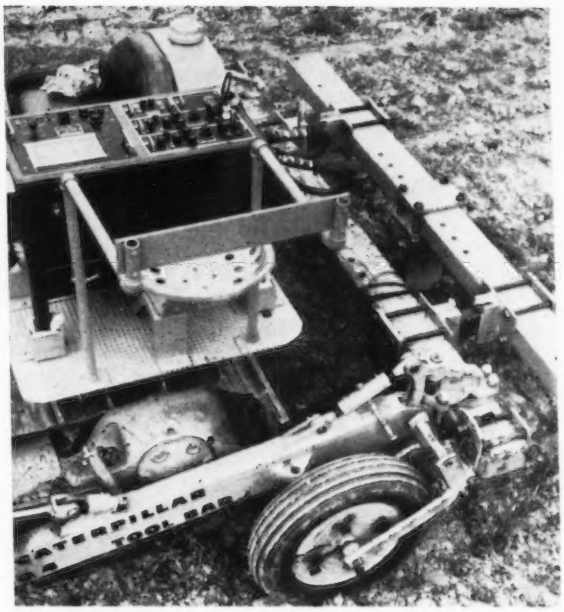

Fig. 2 Strain gage dynamometer in the development stage. Work cooperative with Caterpillar Tractor Co., Peoria, Ill., and Rome Plow Co., Cedartown, Ga.

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The Application of Soil Fumigants

E. F. Feichtmeir and Merrill L. Adams
Member ASAE

Development of Efficient, Safe Methods of Distribution and Application of Chemicals to the Soil Presents a Real Challenge to Engineers

FEW people would argue that D-D* soil fumigant, methyl bromide, chloropicrin, etc., are soil fumigants. However, some people might seriously question whether aldrin, dieldrin or heptachlor are soil fumigants. In spite of the fact that the vapor pressure of dieldrin is only a fraction of a millimeter of mercury, there are data which show that its movement in the vapor phase is important in its control of insects. Since the limits of fumigants are so ephemeral, it is the authors' intention in this paper to stress the word chemical instead of fumigant and to place main emphasis on nematocides and fungicides.

As we move from the highly volatile end of the spectrum toward the non-volatiles, the problems change from how to reduce loss or escape of the chemicals to how to enhance distribution. In the case of the very volatile materials such as methyl bromide, the main problem is to prevent the chemicals from leaving the surface of the soil too rapidly even though injected several inches deep. Unless a suitable barrier such as a plastic cover or other seal can be employed, the loss of chemical is so great that it is not economically feasible to use them. Phytotoxic residues are not normally a problem with these materials.

On the other hand, the most common commercial nematocides, D-D and ethylene dibromide, have a balance between loss and residual. Since they are inherently phytotoxic, a waiting period between application and planting of two weeks is generally required for the residues to escape. As in the case of the highly volatile chemicals, their nematocidal effectiveness can be increased by use of a seal. However, the requirements for sealing are not so critical, so that some improvement in nematocidal efficiency can be secured with less effective seals. For example, most recommendations suggest the use of a drag or a soil packer for forming a compacted surface layer which acts as a seal.

Another method for reducing the rate of loss is to apply the chemical 12 to 14 inches below the surface. This means that it will take longer for the chemical to escape. Other factors which affect vapor loss are the moisture content and the amount of stalks or undecomposed organic matter. The latter act like stovepipes in releasing the chemical from the soil. The general recommendation that the soil be prepared to good seedbed condition avoids these problems to a large extent.

To summarize what has been learned in the past ten years about these volatile materials, it can be said that you can enhance efficiency by making deep injections, by having the soil in good moisture condition and tilth, and by employing a surface seal. The main location for misses or escapes is at the soil surface. Any equipment or techniques which would improve surface sealing would be an asset.

In the last few years we have developed a chemical, 1, 2-dibromo-3, chloropropene, called Nemagon* soil fumigant, that has forced us to alter some of our concepts. Although this material is an effective nematocide, it differs from D-D soil fumigant and EDB in that it remains in the soil in nematocidal concentrations for several weeks without injury to many crops. In this case long residual becomes an asset. Nemagon still moves rapidly enough in the soil so that it can be applied on 12-in. centers (over-all treatment) similar to D-D soil fumigant and ethylene dibromide, or by row treatments with a single shank down the center of the row. However, there is some indication that its efficiency can be enhanced by placing the chisels closer together on over-all treatments, or by using two chisels in row applications.

More recently we have been working with an experimental fumigant which has given us variable results. This chemical has a lower pressure and rate of movement in the soil than Nemagon and is not phytotoxic to a number of crops. Unfortunately, in our early trials, we applied the chemical by the same method used with D-D and ethylene dibromide. This year we ran additional tests by spacing the injections 6 in. apart instead of the usual 12 in., in order to assist the distribution of the chemical through the soil. The results were sufficiently encouraging for us to consider making general distribution of samples to cooperators next year. We have experimental materials of still lower vapor pressures as do American Cyanamid, Virginia Carolina, Diamond Alkali, and others, whose movements are even more restricted. Some of these materials are effective nematocides if they can be distributed uniformly throughout the soil.

There is a great deal of interest in the slightly volatile nematocides and we are approaching a point where there is no sharp demarcation between fumigants and non-fumigants. It doesn't seem right that inherently active materials should automatically be discarded simply because they do not move rapidly. We believe that this is a problem on which mechanical ingenuity should be brought to bear; in other words, if the equipment for application can be altered so that distribution of the chemicals can be enhanced, perhaps these slow movers will become useful contributions to future agriculture.

In the case of soil fungicides, many of the current commercial products such as Captan, Dithane and PCNB have very little fumigating action. It has been necessary to distribute the chemical mechanically to secure favorable results. Therefore, the use of these materials has been largely

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1958, on a program arranged by the Power and Machinery Division.

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*Registered trademark U.S. Patent Office.

restricted to control of shallow or surface diseases, with application usually made in the seed row at time of planting. Handled in this way, these chemicals have been effective in controlling seedling diseases of cotton, etc. It might be suggested that materials with fumigating action should be employed for these uses to avoid the need for mechanical distribution. However, this does not seem to be the answer. The problem is to secure chemical control of the disease at the surface. This is the weak point of most soil fumigants because of their tendency to escape before affecting control of organisms at or near the surface.

The problem of securing uniform distribution of slightly volatile chemicals is also present in the fields of insecticides and weed control. Industrial and experiment station workers have found that certain herbicides which gave extremely variable results when sprayed on the soil surface are fairly consistent when distributed in the upper inch or two of soil. There is a real question as to how many materials are on industry's shelves because of lack of proper equipment for field evaluations. It is apparent that there is a universal need in all of these fields for good mechanical means of chemical distribution.

If good equipment could be developed for distribution at deeper levels, there would be a place for slightly volatile chemicals in both the nematocide and the soil fungicide fields. Some of the most destructive fungi to tree crops and perennials are those which attack at levels of 12 in. or deeper.

At present the distribution of chemicals in the soil by mechanical means is still in its infancy. The employment of conventional rotary tillers does not appear to be the answer, since tests have shown that a chemical applied to the surface followed by rotary tillage largely remains at the surface with the best distribution in depth occurring at the outer edges of the strip to which applied.

What are some other needs for equipment and trends in soil pesticides? One of the more rapidly growing techniques is the application of pesticides in granular form or to solid fertilizers. This procedure has been intriguing to experiment station and industrial workers. However, when one searches for good practical application equipment which is cheap and effective, it becomes apparent that the supply is very limited.

For all types of liquid and granular applicators there is a need for equipment that has feed mechanisms geared to the ground. Although there have been some recent introductions, most of the current equipment is not geared to the ground. Pressure equipment using a pump attached to a power take-off or gravity flow applicators are generally used for liquids. For accurate application, these are dependent on uniform speed of travel, which seldom occurs. The main objection to gearing to the ground is apparently the cost inherent in such design.

In the past farmers have been very dogmatic in their demand for low-priced equipment. Unfortunately they pay many times the cost of good equipment in the cost of extra chemical required as a safety factor because of inadequacies of their equipment. However, farmers are becoming more receptive to paying higher prices for equipment if they can profit by so doing. If engineers develop good equipment which is useful to the progressive grower, it will be only a matter of time until it finds general acceptance.

With some of the slightly volatile chemicals there is the problem of storage life after the chemical has been applied to the granules or fertilizers. The chemical may not be stable for long periods or may escape from the normal packages. There have been attempts to avoid this problem by mixing at time of application, or combining separate applications on the same equipment as one company has done with their seeder-fertilizer-insecticide applicator.

Another interesting improvement in this direction has been that of adding granular insecticides or nematocides to a rotating barrel-type fertilizer applicator just prior to the application. The rotation mixes the pesticide with the fertilizer and applies both in one operation, thus avoiding the problems of storage stability and stockpiling of a variety of fertilizer mixtures.

Anyone familiar with the problems in the pesticide field considers the handling of the technical material as the most critical step in the operation of applying highly toxic or obnoxious chemicals. If operator contact with the chemical could be avoided by mechanical means, it would be a worthwhile contribution. We have tried simple orifices on the inlet side of the pump with fair success. However, this technique has certain problems involving changes in pressure, packing, vapor lock, etc. Nevertheless the possibility of mechanical emulsification of a variety of materials in water is extremely intriguing. Such equipment would minimize storage stability problems, reduce the handling hazards, and might reduce the requirements for emulsifiers. It could be used in application of chemicals in irrigation water and in many spray operations.

It seems to the authors that these problems of developing more efficient methods of distribution of chemicals, of applying granules, combining fertilizers and pesticides, and the safer handling of toxic and obnoxious materials, constitute a real challenge to your ingenuity.

EJC Sponsors Student Exchange Program

WORD has been received that the Engineers Joint Council has become the sponsor for the United States Committee of the International Association for the Exchange of Students for Technical Experience (IAESTE), and its secretariat is located in EJC's headquarters in New York.

IAESTE is an international, non-governmental, non-profit organization founded at London University's Imperial College in 1948 for the purpose of providing on-the-job training in foreign industry for student engineers and scientists. Its initial ten Western European member countries began the program with an exchange of 920 students. At the close of 1958, 39,996 students had been exchanged in this international program between its 26 member countries.

In the operation of the program itself, advanced university students use the facilities of the U.S. IAESTE Committee to arrange for training in the industrial techniques of another country. At the same time, foreign students come to the United States for a training experience with American industry. The program is reciprocal, and the number of American students who can train in a foreign country depends upon the number of foreign IAESTE students who will train in the United States. For further details contact Josef Wischeidt, Jr., executive secretary, U.S. IAESTE Committee, c/o EJC, 29 W. 39th St., New York 18, N. Y.

Field Experiences in Measuring Hydraulic

INTRODUCTION

HYDRAULIC conductivity of the soil, considered to be one of the most difficult factors to evaluate quantitatively for drainage design purposes, has received much attention and study during recent years by those working in the field of soil and water management. During the Winter Meeting of the ASAE, held in Chicago, Illinois, in December 1956, the Drainage Research Committee of the Soil and Water Division conducted a technical session on the subject to discuss different methods of measuring hydraulic conductivity and to report on field experiences with these methods. Following is a symposium of papers and discussions by those who participated in the program.

Soil-Core Method in Virginia

Phelps Walker
Member ASAE

Hydraulic conductivity measurements have been made on a large number of soil types by technicians of the USDA Soil Conservation Service and several state agricultural experiment stations in eastern United States. These data have served as a basis for estimating factors in drainage, irrigation and hydrologic designs.

In Virginia, some 450 different hydraulic conductivity measurements were made on key soil types throughout the state. The method used is described by Uhland and O'Neal (8)* and consists essentially in securing core soil samples from the field for conductivity measurements in the laboratory.

It was found that for this technique the optimum soil moisture content for sampling was just below field capacity. In dry soils the cores tend to shatter. In wet soils the cores tend to puddle. It has been observed that some so-called aquifer soils and most unstable, fluid type soils are impossible to sample satisfactorily.

TABLE 1. DATA SHOWING VARIATION IN PERCOLATION RATES IN REPLICATE DETERMINATIONS OF BLADEN VERY FINE SANDY LOAM, NORFOLK COUNTY, VIRGINIA

Site Va. 136		Site Va. 137	
Core no.	Percolation, in. per hr	Core no.	Percolation, in. per hr
401	0.14	416	0.11
402	0.11	417	0.07
403	0.43	418	0.09
404	0.20	419	0.07
405	0.09	420	0.07
Average	0.19	Average	0.08
Low Limit	0.02	Low Limit	0.06
High Limit	0.36	High Limit	0.10

95 percent of values will occur between low and high limit.

In analysis of data from the Uhland type cores, concern has arisen over the variations in much of the data. Variation occurs not only within test sites but also among replicate sites of what is believed to be similar soils as is shown in Table 1.

W. L. Turner(3), formerly soil scientist for the Virginia permeability survey, proposed to qualify the average percolation rate by indicating the spread in data with fiducial limits. This would give the user of the data a fair concept of the degree of dispersion that exists within a given set of replicate cores. In Table 1, the spread for site Va. 137 is only from 0.06 to 0.10 in. per hr, while that for Va. 136 is from 0.02 to 0.36 in. per hr. The mechanics for computing the limits are long and time consuming. As a result, the proposal met with favor only in Virginia.

Recently all available data were analyzed by Mason, Lutz and Petersen(6) at North Carolina State College. Preliminary reports(8) on this work indicate that the number of permeability classes should be reduced from the present seven accepted classes. Other changes in field procedure may be indicated.

The user of the present data has through necessity accepted the spread in data. With this reservation, engineers and soil scientists in several states have made practical use of existing data. Devereux, Steele and Turner(2) based land classification recommendations for drainage, irrigation, farm ponds, and other soil and water conservation practices upon field permeability measurements. Transmission rates and soil storage capacity values derived from field determinations were used in the preparation of irrigation guides for two regions of Virginia. Holton and Kirkpatrick(4) made similar application to hydrologic investigations. Slater (7) and Walker(9) used core-sample data in each of their methods for obtaining values for depth and spacing of tile drain laterals.

Summary

The soil-core hydraulic conductivity survey program provided information which has been used as a basis for more accurate land classification surveys and better engineering designs of soil and water conservation structures.

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Symposium, sponsored by the Committee on Drainage Research (1956-57), Drainage Group of the Soil and Water Division, American Society of Agricultural Engineers, was presented at the Winter Meeting, Chicago, Ill., December 1956. Committee members were G. O. Schwab (chairman), J. R. Davis, W. W. Donnan, R. W. Irwin, and Jan van Schilfgaarde. W. W. Donnan compiled and edited the material for this report.

The author — W. W. DONNAN — is drainage engineer, Western Soil & Water Management Branch (ARS), USDA, Pomona, Calif.

*Numbers in parentheses refer to appended references.

Conductivity for Drainage Design

— A SYMPOSIUM

Compiled by **W. W. Donnan**
Member ASAE

There are serious limitations in the data due to lack of replications of tests in similar soil conditions. Perhaps another mistake has been made in attempting to set up too many permeability classifications.

Better information of water movement through soils is one of the basic needs in developing efficient soil and water conservation practices. The soil-core method of measurement is one means of studying this phenomenon. Further refinement of procedures would undoubtedly result in more reliable design data.

Auger-hole, Piezometer and Two-hole Methods in Idaho

R. William Nelson
Assoc. Member ASAE

Three field methods of measuring hydraulic conductivity were investigated at a selected site near Boise, Idaho. The three methods were: *(a)* the auger-hole method; *(b)* the piezometer method; and *(c)* Childs' (1) two-hole method.

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Fig. 1 Concrete cast for auger-hole method. A commercially produced liquid rubber was also used to cast cavity shapes below the piezometers in the piezometer method

Several interesting complications were observed when conducting the reproducibility study. These included irregularity of cavity shapes, air movement above the water table and pore clogging in the two-hole method.

In investigating cavity shapes, an attempt was made to make concrete casts of the cavity after the field tests were completed. Fig. 1 shows a picture of one of the auger-hole casts. A commercially produced liquid rubber was also used to cast cavity shapes below the piezometers in the piezometer method. The material used was PR 395 (thicol base) liquid rubber.

This material can be poured into the piezometer. It proved satisfactory, but expensive. Examination of cavity casts indicates that the cavity in both the auger-hole method and the piezometer method is seldom uniform. Thus, since the cavity shape is the primary boundary affecting flow, errors in measurement of hydraulic conductivity could be attributed to these irregularities.

During one sequence of tests considerable air movement from the soil was observed. At the test site, the soil above the water table was extremely dry. When water was introduced into the piezometers, dust rose from the ground surface, indicating considerable movement of air upwards through the soil. It has not been determined what happens when the soil mantle above the water table is not dry and air is thus trapped in the lower profile. Does this retard the movement of water into the profile?

In Childs' (1) two-hole method, water is pumped out of one hole and returned to a second hole a few feet away via piezometer tubes. Since the measurement equation is based upon the steady state case, the water must be circulated until steadiness is approached. It was found that water circulation for extended periods of time resulted in pore clogging which in turn affects the measured hydraulic conductivity. Possibly this type of difficulty can be overcome by using a four-hole method, as suggested by Kirkham(5).

Summary

All of the field methods, namely the piezometer, auger-hole and two-hole methods, have in their procedure a measure of conformance to the theoretical case. Obviously, if the agreement is good, some confidence can be had in the calculated hydraulic conductivity. Should the agreement be poor, just as the designer of a machine part changes the factor of safety with the precision with which he can estimate the forces involved, so must the drainage engineer apply different factors of safety when utilizing the measured value of hydraulic conductivity.

Realizing these difficulties, the author believes that the field methods still provide the best estimate available for hydraulic conductivity due to it being an inplace measurement on a larger soil volume than usually is used in the laboratory.

Auger-hole and Piezometer Methods in Indiana

A. F. Klinge and John R. Davis
Member ASAE

Initial field research in 1955 on drainage feasibility in southern Indiana involved the determination of soil physical characteristics in the Clermont soil area. Clermont soil occurs on the flatter central parts of the main divides. It is a light colored soil, with a distinctly acid reaction; and under natural conditions, has very poor drainage due to its flat relief and impervious lower horizons. Mechanical analyses show that from the surface to a 39-in. depth, the percentage of clay increases from 22 to 36 percent, and silt content remains constant at about 53 percent. Volume weight of the lower soil horizons is about 1.58 grams per cubic centimeter.

To determine the drainage characteristics of this soil, water table drawdown measurements were made, in-situ hydraulic conductivity measurements were made using the auger-hole and piezometer methods, and laboratory measurements of hydraulic conductivity using 3-in. cores and a variable head permeameter were made. A summary of the results are presented in Tables 1 and 2.

TABLE 1. HYDRAULIC CONDUCTIVITY OF CLERMONT SILT LOAM SOIL

Soil depth, inches	Hydraulic conductivity, in. per hr	
	Auger Hole	Piezometer
24		0.220
30		0.400
36	0.500	0.650
42	0.062	0.086
48	0.046	0.054
54	0.016	0.028
60	0.036	

TABLE 2. HYDRAULIC CONDUCTIVITY OF SOIL CORES

Soil depth, inches	Hydraulic conductivity, in. per hr
1-4	0.094
4-7	0.115
7-10	0.050
10-13	0.063
18-21	0.055
23-26	0.057
28-31	0.044
36-39	0.006

With the auger-hole and piezometer methods, some difficulty was experienced in maintaining the dimensions of the hole, due mainly to the unstable nature of this soil. Chunks of soil falling from the sides of the cavity resulted in unknown variations in the geometry of the potential flow system and gave rise to possible questioning of the precision of the calculated permeabilities.

The calculated values of hydraulic conductivity for the cores are not expected to show the permanent or absolute permeabilities of the horizons sampled. There was a wide range in the values obtained in the laboratory, although most of the coefficients of variation are within or lower than the values found by other investigators who used the piezometer method in the field.

As an interesting application of the conductivity data obtained in this project, Walker's(9) formula was used to determine the tile spacing in these soils. Table 3 summarizes the calculations for depth and spacing at the Jennings County Experiment Field.

TABLE 3. SOLUTION OF WALKER'S FORMULA FOR THE DEPTH AND SPACING OF TILE DRAINS

Depth of drain from ground surface, feet	2.0	2.5	3.0	3.5
Minimum hydraulic conductivity, feet per day*	0.128	0.128	0.128	0.020
Spacing S, feet	14.3	21.5	32.3	4.1

*Data are from undisturbed 3-in. core samples.

The 32-ft spacing for a 3.0-ft depth is coincident with draw-down measurements, which show the lateral extent of good drainage to be about 30-34 ft. The 32-ft spacing also coincides with the crop yield experiments that have been conducted at the Jennings County Experiment Farm since 1921. These studies indicate a 3-ft depth and a 1 to 2-rod spacing, for the highest yields.

Summary

In-situ measurements of hydraulic conductivity appear to be unreliable in Clermont silt loam soil, unless the geometry of the cavity for the auger-hole and the piezometer measurements can be maintained. Although the difference in hydraulic conductivity between replications for each method was slight, the difference between the two methods and between the in-situ methods and core samples was great. Tile spacings calculated from Walker's formula, using values of conductivity calculated from soil cores, coincide with all other field measurements; indicating that in this soil, core samples may be more reliable for the determination of hydraulic conductivity.

The authors — A. F. KLINGE and JOHN R. DAVIS — are, respectively, former assistant professor and former instructor, agricultural engineering department, Purdue University, Lafayette, Ind.

Piezometer Method in Ontario

F. R. Hore
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While conducting hydraulic conductivity determinations by the piezometer method on a Brookston clay loam soil near Chatham, Ontario, some field checks on this technique were made. These checks showed that the method does not work in practice as expected from theory.

Field work was performed on eight replicate piezometer tubes at the 2-ft depth. Each piezometer had an internal diameter of one inch and had a $^{15}/_{16}$-in. diameter cavity 4 in. in length below the tube. Observed data, L_r, h_1 at time of t_1, and h_2 at time t_2 required in the field are shown in Figure 1. Two closely related field checks concerned with the head differentials selected in the piezometer were made to determine their effect on the computed hydraulic conductivity. The first check showed that as h_1 is decreased and $\Delta h = (h_1 - h_2)$ is held constant, the computed hydraulic conductivity decreases. The second check showed that the computed hydraulic conductivity decreased proportionately with an increase in Δh when h_1 was held constant.

A proposed explanation for these irregularities is based on non-uniform soil conditions and a difference in hydraulic head conditions causing flow into the piezometer from those assumed in the theory. Visual inspection of the soil struc-

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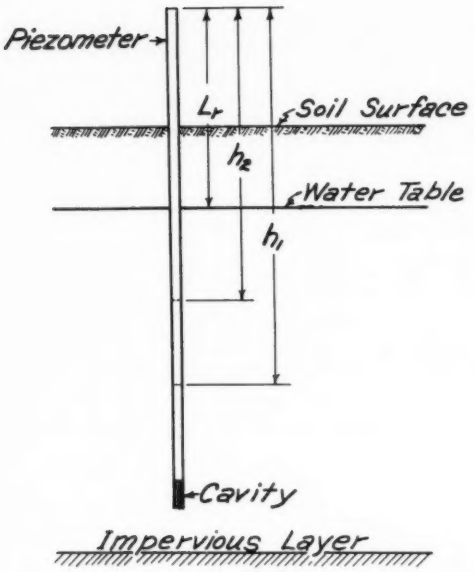

Fig. 1 Observed data required for the piezometer method

ture revealed the presence of different sized fissures and passages as shown in Fig. 2. Opening *A*, opening *B*, and fissures *C* are assumed to be interconnected and to have conductivity values of high, medium, and low, respectively. When water is removed from the piezometer for a test, the water in opening *A* will drop to some level X below the original water table. Therefore, as h_1 decreases or Δb increases, the actual head causing flow into the cavity is less than the theoretical head, which causes an apparent decrease in the computed hydraulic conductivity.

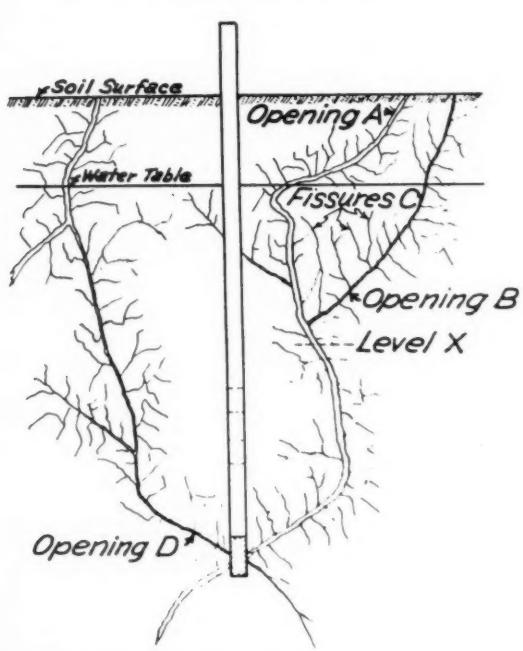

Fig. 2 Diagrammatic representation of hydraulic conditions about a piezometer in a fissured fine-textured soil

Variations in hydraulic conductivity between replicate piezometers were also observed. If by chance an opening the size of opening *A* leads to the cavity, large values of hydraulic conductivity will be observed. However, if only a small sized opening such as opening *D* leads to the cavity, small values will be observed.

The proposal is advanced that in structured soils the hydraulic conductivity of individual fissures and passages rather than the hydraulic conductivity of the soil mass as a whole is measured by this method. It is therefore felt that the method is not entirely satisfactory under these soil conditions. The question could also be raised as to whether hydraulic conductivity of the soil is ever measured by any method in highly structured soils.

Shallow Well Pump-in and Auger-hole Methods in Colorado

Ray J. Winger, Jr.
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Following is a report on several methods used by the Bureau of Reclamation, USDI, to determine hydraulic conductivity.

Shallow Well Pump-In Method

This method was developed to determine the hydraulic conductivity of the subsoil above the water table when the ground-water table is at a considerable distance below the normal drainage depth. The solution is based upon an approximate mathematical analysis. A comparison of electrical analogy test results for conditions similar to those assumed in the development of the formula showed appreciably lower values were obtained experimentally. These deviations varied from 25 percent at $H/r=6$, to 8 percent at $H/r=20$, where H=the depth of water in the well and r=the radius of the well. This indicates that the approximate mathematical analysis has reasonable validity for $H/r=10$ and over.

Briefly, this test is conducted by augering a hole to 10 ft, more or less, depending upon the section of the soil profile that is to be tested. A calibrated tank supplies the water and is connected to a carburetor float set in the hole, which holds the head at the level desired. The Bureau of Reclamation has developed a formula and a nomograph to determine the "minimum" volume of water that must be applied, before the final run is made. The minimum volume of water is the amount of water that must be applied before the steady state flow is reached. The most accurate method is to run the test until a steady state flow has been reached, and then start the 3 or 6-hour test run. The final test run will give the steady state flow in cubic feet per minute, and from these data the permeability can be computed by formula or by the nomograph.

Auger-Hole Method Below the Water Table

This appears to be a good method for determining the composite lateral hydraulic conductivity of a section of the soil profile, and data obtained by this method can be used for designing farm drainage systems. Once the equipment has been assembled, a number of these tests can be run daily. When using a 400-ft grid system, the auger-hole

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(Continued on page 280)

Finishing building which houses hogs from 50 lb to market weight on Max Bailey farm, Story County, Ia.

Improved Operating Efficiencies Increase Pork Production

Albert E. Powell
Member ASAE

A Combination Engineering-Management System Points the Way to More Profitable, Large-Scale Production of Market Hogs

THE business of raising hogs on American farms is fast becoming the business of producing pork. It is becoming less an enterprise and more an industry. As an industry it has been more subject to examination of factors which lead to efficiency of production. Some of these factors are capital, marketing, labor, breeding, nutrition, housing and equipment, and disease control. There may be others. However, all affect the profits of the pork producer, as well as does the ability of the producer or manager to coordinate these factors into an efficiently operating industry. This is management. Some of these factors carry more weight than others; many are interrelated. More progress has been made in some factors than in others. One thing is obvious. The buildings and equipment on the majority of farms are not adding materially to the efficiency of pork production. Buildings and equipment specifically designed to fit the pork production process under a specific system of management are needed if efficiency is to be achieved.

This sort of thinking led to the inception of a project near Ames, Iowa, in the summer of 1956. The project was a cooperative one between Max Bailey, farmer, and the Douglas Fir Plywood Association. Mr. Bailey farmed 173 acres in Story County, Iowa. He raised hogs on a commercial basis, farrowing and marketing four times a year. The seasonally low prices of 1955 and 1956 brought Mr. Bailey to the conclusion that he had to put his pork production on an efficient industrial basis to make it profitable. This was his objective. DFPA was interested in demonstrating the suitability of exterior-type fir plywood for use in farm structures, and thus the cooperative project was started.

In this project Mr. Bailey represented management and would coordinate the various factors of production. Extensive study by him led to the decision to base his system of management on the Iowa system of life cycle swine production developed at Iowa State College, with housing and equipment designed for a schedule of eight plus farrowings per year.

Fig. 1 illustrates the system of pork production for which buildings and equipment were needed. During the pregestation and gestation periods the sows are held in the field. A few days before farrowing the sow is brought into a farrowing house where she remains until the pigs are weaned. The sow is then taken to her shelter in the field where she will remain until her next trip to the farrowing house. The pigs are weaned at from 3 to 5 weeks, after which they are transported by trailer to a growing building. With the farrowing house on a schedule of being filled once every six weeks, this leaves approximately one week for cleaning the house for the next cycle. The pigs are kept in the growing building from 3 to 5 weeks. When they are about 8 weeks old and weigh from 40 to 50 lb, they are transferred by trailer to a finishing building. This puts the growing building on a schedule of being filled every six weeks, allowing one week for cleaning. Although this timing requires only one growing building, two growing buildings are used in order to provide a rest period for each building between uses. Each growing building rests for six weeks between uses. This was done to facilitate disease control. The hogs are kept in the finishing building from 12 to 16 weeks or until reaching a market weight of from 200 to 225 lb at from 5 to 6 months of age. This is the management system for which buildings and equipment were designed.

The first step was to analyze the building and equipment requirements for each stage of the hog's life. The sow in the field posed little problem. A simple shade shelter which could be closed to afford some protection during colder weather should suffice for this mature animal. The farrowing and growing periods were the most critical in the pig's life. Control of environment is necessary to keep a low mortality rate and a high rate of growth in the pig from birth to 50 lb. During the period from 50 lb to market weight, environment control is not critical. It was in this period that the greatest volume of feed and manure

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1958, on a program arranged by the Farm Structures Division.

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had to be handled. Therefore, expenditures in the farrowing house and growing building basically were to be for the control of environment. They were to be for shelter, insulation, artificial heat, and forced ventilation. In the finishing building, expenditures basically were to be for mechanization of the feeding and cleaning operation, although shelter and ventilation also were major considerations.

The basic plan of the farrowing house as developed and later modified is shown in Fig. 2. Originally 28 farrowing stalls 7½ ft long and 5 ft wide were installed. The area later modified into four additional farrowing stalls originally was used as two holding pens near the wash area, and the area later modified into holding pens originally was set aside for bedding storage. The building was heated by a hot water heated floor system as indicated by the dotted line in the figure tracing the path of the ¾ in. copper tubing buried in the concrete floor. The tubing provided heat under the creep area for the young pigs only, and went around in front of the sow to avoid evaporating urine at the rear. Since the sows were to be in full confinement in the farrowing stalls until the pigs were weaned, each sow was provided with an automatic waterer and with a feeder on the feed alleys along the outside of the building. These feeders were filled from a feed cart which was filled from a bulk feed bin above the holding pens at one end of the building. Automatic waterers for the pigs were provided separate from the waterers for the sows, one between each two farrowing stalls. Construction of the building proper was concrete floor and foundation wall, ⅜-in. exterior fir plywood combination siding and sheathing over 2 x 4-in. studs 24-in. on centers, 2-in. insulation batts with vapor barrier on the inside between studs and ⅜-in. exterior fir plywood lining. Ceiling was ⅜-in. exterior fir plywood lining over light trusses 24 in. on centers with 2-in. insulation batts with vapor barrier on the inside between trusses, ventilated attic space and ⅜-in. plywood deck over. The building was windowless, except for two 24 x 48-in. pieces of insulating glass put in the sidewalls for observation only. Ventilation was provided by a combination forced intake and exhaust system utilizing ducts for distribution.

The growing building (Fig. 3) was 28 by 104 ft in size and was identical in construction with the farrowing house. The same ventilation system was used, also the same heated floor system using the same boiler and pump. However, the copper tubing was placed differently in the floor. In this building the pens were arranged in such a manner as to encourage the use of the alley on the outside of the building to dung, thereby facilitating cleaning. The location of the automatic waterer in the alley and the placement of the heat pipes to provide a warm, dry bed in the center of the pen were intended to encourage use of the dunging alley. Closing the dividing gates between pens closes all pigs in their pens and opens up the dunging alleys for scoop cleaning through the center doors. A feed bin above the bedding storage on one end of the building was provided to permit distribution of feed to the central feeders by cart. This growing building was sized to take care of the output from a 32-sow farrowing house. On the basis of from 8 to 10 pigs saved per litter, each pig was allotted from 8 to 6 sq ft of space. A

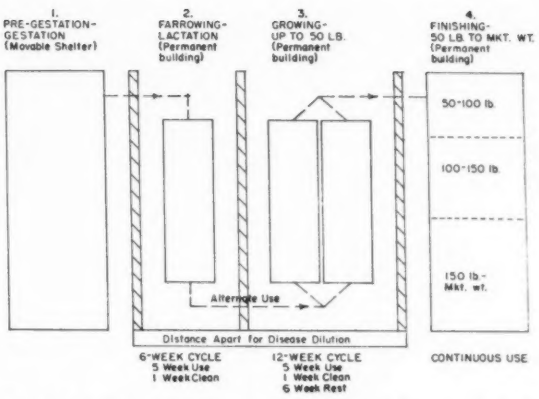


Fig. 1 General layout of the pork production plant on the Bailey farm, designed for eight plus farrowings per year

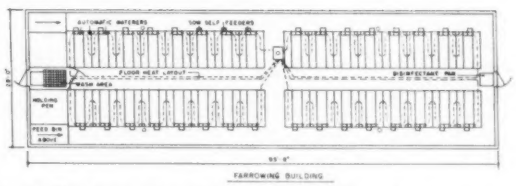


Fig. 2 The basic plan of the 28 x 96-ft farrowing house on the Bailey farm

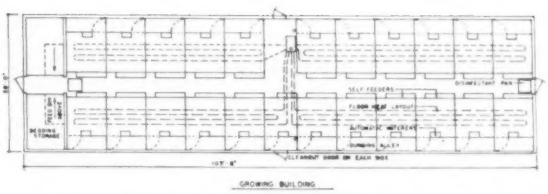


Fig. 3 Ground plan of the 28 x 104-ft growing building of the Bailey hog production plant

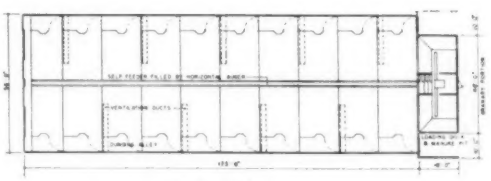


Fig. 4 Ground plan of the 56 x 160-ft hog finishing building with 16 x 40-ft granary

similar arrangement was worked out in the remodeling of an outdated farrowing house for the second growing building.

The finishing building shown in Fig. 4 was 56 by 160 ft in size, with a 16 x 40-ft granary on one end. This finishing building also was sized in accordance with the output from a 32-sow farrowing house. The approximate time from birth to market for the hog may vary from 20 to 24 weeks. During this period the farrowing house during four cycles of farrowing would produce from 1024 to 1280 pigs on the basis of from 8 to 10 saved per litter. The finishing building provided for from 9 to 7 sq ft per hog. This building in floor plan arrangement was a larger version of the growing building with the feeder in the center and the dunging alleys and automatic waterers along the outside of the building. It was hoped that the habits learned of using the dunging alleys in the growing building would carry through to the finishing building. Closing the hogs in the pens by closing the 6-ft gates which formed the partitions across the dunging alleys permitted mechanized cleaning of the alleys by a scoop on the front end of a tractor. The grade level on one end of the building was about 5 ft lower than that on the other end. This permitted pushing the manure over the edge onto a concrete apron to be loaded into a manure spreader and disposed of later. This same concrete apron, established at the proper grade, permitted a truck to back up on the cleaned apron and load market hogs directly into the truck at dock height. The finishing building essentially was a shelter shell. Construction consisted of concrete floor and foundation, 2 x 4-in. wall studs 24 in. on centers with ⅜-in. exterior fir plywood as combination sheathing and siding on the outside, and a truss-purlin-rafter system with a ⅜-in. plywood roof deck over. All pen partitions and gates in the building were ⅝-in. exterior plywood 36 in. in height. Continuous doors 3 ft high by 8 ft long along both sides of the building were placed at partition height to provide ventilation in warmer weather without drafts at floor level. In addition, nine forced-intake fans utilizing ducts for distribution and four large gravity roof ventilators were included to handle ventilation when there was no natural breeze or during colder weather when closer control was needed than could be obtained by using doors. No provision was made for automatic control of these fans, since the control requirements were not known at that time. Each fan was on manual switch control and ventilation was regulated manually by the operator.

It was in the finishing process of the hog from 50 lb to market weight that the great bulk of feed and manure were to be handled. Development of use of the dunging alley in the growing building and its carrying through into the finishing building in such a form as to permit mechanized cleaning was the solution to the handling of manure solids. A septic tank was added to handle the liquid portion of the manure.

The feeding operation was judged of sufficient importance that it was housed in a 16 x 40-ft granary on the end of the building. Profitable buying practices as well as sufficient storage of feed to carry through periods of inclement weather were considered in the design of the feeding

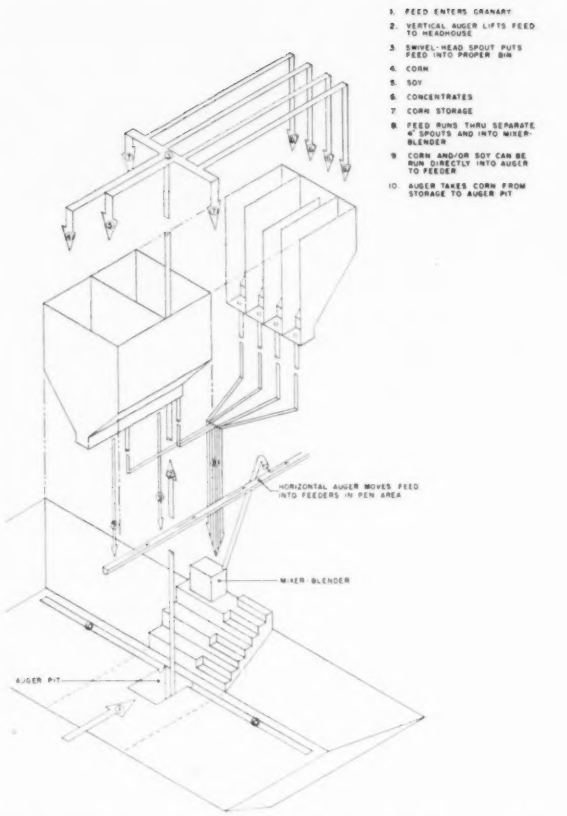

1. FEED ENTERS GRANARY
2. VERTICAL AUGER LIFTS FEED TO HEADHOUSE
3. SWIVEL-HEAD SPOUT PUTS FEED INTO PROPER BIN
4. CORN
5. SOY
6. CONCENTRATES
7. CORN STORAGE
8. FEED RUNS THRU SEPARATE 4" SPOUTS AND INTO MIXER-BLENDER
9. CORN AND/OR SOY CAN BE RUN DIRECTLY INTO AUGER TO FEEDER
10. AUGER TAKES CORN FROM STORAGE TO AUGER PIT
HORIZONTAL AUGER MOVES FEED INTO FEEDERS IN PEN AREA
MIXER-BLENDER
AUGER PIT

Fig. 5 This illustrates the flow of feed through the granary in the Bailey hog production operation

system and of this granary. The flow of the feed through the granary is shown in Fig. 5. To each side of the central mixing area were two storage bins with a combined capacity of 6000 bu. Above the mixing area were six bins. Two of these were two-way slope bins, each with a capacity of 350 bu. Four were one-way slope bins, each with a capacity of 75 bu. Feed entering the granary was dumped or augered from the truck into the pit of a 6-in. vertical auger from which it could be spouted into any one of the eight bins. From any of the six bins above the mixing area, ingredients fed by gravity into a grinder-blender. From this grinder-blender it was re-elevated by a short 4-in. auger and dumped into a 6-in. horizontal auger which ran the length of the building. By manually opening or closing the slots in the bottom of the auger trough, the particular blend could be dumped into any section of the central feeder. Thus it was possible to change the protein level of the feed used in every 16-ft length of the feeder. Horizontal augers in the floor of the side storage bins permitted movement of the stored feed into the auger pit for elevation to an overhead bin for gravity feed into the grinder-blender. Provision also was made for sacking feed from the grinder-blender and for gravity flow of feed from the end overhead bin to a wagon outside in case of emergency.

This enterprise was put into operation in January 1957 when the first sows farrowed in the new building. Produc-

tion was not started at design capacity since it was obvious that there were problems in management that would have to be worked out by trial and error. It took approximately a year to get into full production, so it has been only during 1958 that the system really operated at design capacity. During this period of favorable pork prices, the system actually has been operated at a production figure of 3,000 hogs per year, rather than the design figure of 2,400. During the two-year period of operation of this pork production plant, it has been possible to make several observations. These observations cover basically housing and equipment, disease control, and management, although they do touch on some of the other factors entering into efficient pork production.

The use of the portable shade shelter for the sow during the pregestation and gestation period has worked out well with respect to buildings and equipment and management. The main problem encountered was that of actually getting the sows bred when desired. This was helped by arranging the pens for the sows and the boars in the field so there was a boar pen between each two sow pens with a gate which could be opened into the particular pen desired. The sow setup found most desirable was a semipermanent pen arrangement or a confinement system in the field. About the only time the sows got out of these pens was to glean the cornfields after the picker.

The farrowing house has worked out well. Among the first items noted was that bedding was not needed in the creep areas since the floor was heated. The use of bedding was eliminated completely soon after the building was put into operation. The bedding storage area was turned into holding pens, and the holding pens were turned into farrowing stalls for conversion to a 32-sow farrowing house. However, it was found necessary to turn on the heat in the warmer months to warm the floor in the creep area enough to keep the young pigs from going to the sow for warmth and getting laid on. Observations of labor efficiency in this house led to the conclusion that it called for less labor to turn the sows out twice daily to feed and dung than it did to feed the sow inside and to clean the manure out of the building. A concrete apron 16 ft wide was poured along the south side of the farrowing house, self-feeders and automatic waterers were installed in this area, and the full confinement system for the sow was abandoned. The sow no longer was fed in the farrowing stall. This resulted in the cleaning of less than a scoopful of manure a day out of the farrowing house, thereby reducing labor materially. The elimination of bedding and the turning the sow out to feed and dung also solved a ventilation problem. In colder weather it was difficult to ventilate adequately to keep down odors and moisture in the building and still prevent drafts in the creep areas. Elimination of the bedding gave the urine a chance to get into the drain and out of the building instead of being soaked up in the bedding and evaporated into the air. Elimination of the manure from the building reduced odors and also reduced the moisture load. With the elimination of bedding and with turning the sow out to feed and dung, it was possible to ventilate adequately in colder weather without drafts.

The growing building has worked satisfactorily in all respects but one. In general, the theory of the use of the dunging alleys by the young pigs has worked fine in the cooler months when the pigs are drawn to the warm heated slab to sleep and are forced to dung away from their beds. When an occasional pen of pigs has not reacted properly, messing has been localized and the pen has been cleaned into the nearby dunging alley. This has made it a simple matter to close the gates and to clean the manure from the dunging alley with a scoop. There is no great volume of manure or feed to be handled in this building, so mechanization of the cleaning or feeding operations has been judged not economically feasible at this time. During the three warmer months, when the pig is seeking a cool place to rest, the dunging alley system partially breaks down. The pigs will lie in the dunging alley to keep cool and will carry the manure into their pens, or they will dung in the pens. The labor requirement for cleaning this building definitely goes up in the summer, in addition to the fact that the pigs themselves are dirty. No solution has been developed to this problem as yet. Under consideration are the circulation of cooling water in the heat pipes and the use of spray nozzles. Since the problem has not been especially costly in labor and has had no other apparent ill effects, the solution will have to be rather inexpensive.

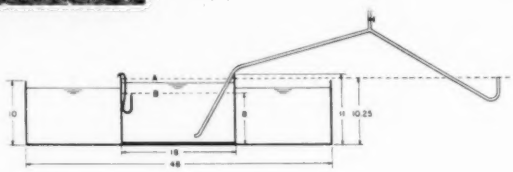
The finishing building has performed as an efficient hog finishing unit. The only real problem encountered in this building is the same as that encountered in the growing building, the breakdown of the dunging alley system in the warmer months. In this building the system breaks down completely in the warmer months and the hogs are finished in conditions which are unsightly to say the least. The hogs lie in the dunging alleys to keep cool, they generally manage to plug the drains, and the whole building becomes a manure-spattered mess. Several solutions are under consideration at the present time. The use of spray nozzles coupled with going to liquid manure in the warmer months seems to offer the most promise. Here again there is no economic justification for anything but an inexpensive solution to this problem, since the unsightly condition of the hogs seemingly has had no adverse effect on their growth or market value. Even during the warmer months the bulk of the manure is in the dunging alley where it can be pushed from the building by tractor. Hand shoveling is necessary to get some of the manure from the pens, but the distance from the pen to the dunging alley is not great.

The mechanization of the feeding operation has been entirely successful. The job of feeding approximately 20 tons of feed per week without lifting or scooping one shovelful of this feed has been accomplished with a small amount of equipment and with low expense. The one small problem encountered has been lodging of some of the additives in the 4-in. tubes for the gravity flow from the bins to the grinder-blender. This has been solved by the use of pelleted additives and by the use of heavy mineral and vitamin premixes mixed with rolled or crimped corn. The use of the premixes also has facilitated mixing in the grinder-blender since there is more volume to the additive.

There are no windows as such in any of these buildings. Whether there is light or not seems to make little difference to the growth of the hog. However, the addition of the two 24 x 48-in. pieces of insulating glass in both the farrowing house and in the growing building did add materially to the convenience of the operator during the day in that he had enough light to move in the building without

Fig. 1 *(Left)* Integrating rainfall-evaporation recorder consisting of a lucite cylinder placed in a standard evaporation pan

Fig. 2 *(Below)* Principle of operation and dimensions (inches) of recorder shown in Fig. 1



INSTRUMENT NEWS

Integrating Rainfall-Evaporation Recorder

Provides Easy if Not Automatic Scheduling of Irrigation

Herman Bouwer
Assoc. Member ASAE

USE of the balance system to determine when to irrigate involves keeping a daily record of evapotranspiration and rainfall or irrigation, and calculating the moisture balance at the end of each day This need for daily accounting could be eliminated by a device that would simultaneously measure and "store" evapotranspiration, irrigation, and rainfall, and that would be equipped with an upper "ceiling" representing field capacity and an adjustable lower mark indicating time to irrigate.

For a discussion of the relative merits of evaporation pans as devices for estimating potential evapotranspiration, reference is made to Mather(3).* Satisfactory correlations between pan evaporation and evapotranspiration have been reported in a number of instances (1, 2, 4, 5). Moreover, the local humid environment in a field that is well supplied with moisture enhances the reliability of pan-evaporation data for estimating the potential evapotranspiration(3). The device discussed in this paper utilizes a 4-ft diameter Weather Bureau Class A evaporation pan. Similar principles, however, can be applied to convert an evapotranspirometer(3) into an integrating recorder of rainfall, irrigation, and evapotranspiration with a field-capacity ceiling and a lower mark indicating time to irrigate.

An Instrument News Contribution. Articles on agricultural applications of instruments and controls and related problems are invited by the ASAE Committee on Instrumentation and Controls, and should be submitted direct to Karl H. Norris, instrument news editor, 105A South Wing, Administration Bldg., Plant Industry Station, Beltsville, Md.

The author—HERMAN BOUWER—is associate agricultural engineer, Agricultural Experiment Station of the Alabama Polytechnic Institute, Auburn, Ala.

*Numbers in parentheses refer to appended references.

Apparatus and Procedure

To reduce the effect of splash losses in recording rainfall with evaporation pans, measurements were carried out on the water level of an 18-in. diameter transparent lucite cylinder placed in the center of the evaporation pan so as to permit splash into as well as out of the cylinder (Figs. 1 and 2).

A field-capacity ceiling was obtained by means of a syphon consisting of small-diameter tubing and an air-collection chamber. The free outlet of the syphon (level A, Fig. 2) was adjusted to obtain a field-capacity ceiling in the cylinder at 0.75 in. below the top of the cylinder. This distance was considered adequate to avoid spilling of waves from the cylinder into the pan. The top of the cylinder was 1 in. higher than the top of the pan, so that the water level in the cylinder was slightly higher than in the pan and flotation of the cylinder was avoided.

A hook gage was used to indicate the lower limit of the soil moisture balance and time to irrigate (Figs. 1 and 2). The distance *AB* between the point of the hook gage and the field-capacity ceiling is determined by the amount of available moisture in the soil and the ratio between the evaporation from the cylinder and the evapotranspiration by the crop. The amount of water to be applied per irrigation is determined by the irrigation efficiency and the number of inches of water required to recharge the moisture reservoir from the lower limit of soil moisture availability to field capacity. After irrigation, the cylinder is filled until the syphon starts operating and water is added to the pan until it flows over the rim of the pan.

For solid sprinkler irrigation systems, for instance, it would be possible to achieve full-automatic irrigation by using electrically-powered pumps in combination with a switching and timing arrangement operated by a float in the integrating rainfall-evaporation recorder. By placing the recorder close to a sprinkler, the cylinder and surrounding pan are automatically refilled to capacity during the irrigation. To ensure complete refill of the device, the

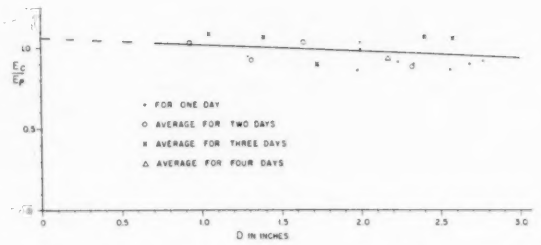


Fig. 3 Ratio between the evaporation from the cylinder and from the standard pan as a function of the distance of the water surface below the top of the cylinder

sprinkler near the pan may even be equipped with a nozzle larger than those used on the other sprinklers.

The distance *AB* must be determined experimentally for a given location and crop, or can be evaluated from applicable studies where pan evaporation has been compared to crop consumptive use at different moisture levels. In view of the number of studies that have been made on the relation between pan evaporation and evapotranspiration, the evaporation from the cylinder (Figs. 1 and 2) was tested against the evaporation from a 4-ft diameter standard pan that was located approximately 10 ft from the pan with the cylinder. The results (Fig. 3) were weighted according to the number of days between consecutive measurements. The following linear equation was determined by a least-squares analyses:

$$E_c/E_p = 1.06 - 0.038\ D \quad . \quad . \quad . \quad . \quad . \quad [1]$$

where E_c = evaporation from cylinder

E_p = evaporation from standard pan

D = distance in inches between water surface in cylinder and top of cylinder.

This equation, which applies to the zone between $D=0.75$ and $D=3.00$, indicates that the evaporation from the cylinder exceeded that from the pan at the higher water levels in the cylinder, possibly because of increased air convection in the presence of the rim of the cylinder. At the lower water levels, however, the sheltering effect by the cylinder apparently became dominant, resulting in lower evaporation from the cylinder than from the pan.

It is of interest to calculate the accumulated evaporation from the cylinder that would be equivalent to certain accumulated evaporations from the standard pan. For this purpose, equation [1] is written as

$$dE_c/dE_p = 1.06 - 0.038\ E_c$$

which can be integrated to

$$E_p + c_1 = -(2.303/0.038)\ \log\ (1.06 - 0.038\ E_c) + c_2\ . \quad [2]$$

where c_1 and c_2 are constants of integration. Taking the field-capacity level in the cylinder at 0.5 in. below the top of the cylinder, equation[2] was used to calculate the following E_c — values as equivalent to E_p — values of 1, 2, and 3 in., respectively:

E_p	E_c
1.00	1.03
2.00	2.00
3.00	2.95

These results indicate that accumulated pan-evaporation values can be used for determining the distance *AB* of the integrating rainfall-evaporation recorder with very little error. The location of the pans for the test results in Fig. 3 was in an unirrigated field. Because of the increased humidity that may be expected if the pans are located in irrigated fields, E_p and E_c may be even closer to a one to one relationship than suggested by Equation[1].

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. . . Pork Production

(Continued from page 277)

artificial light and was able to observe happenings outside when working in the building.

The one item which has caused more difficulty than any other in the operation of this production plant has been disease in the farrowing house. There has been nothing so severe that it has resulted in complete or nearly complete loss of the young pigs, but disease in milder forms has cost efficiency in growth and has caused some baby pig mortality. The disease level in the farrowing house has improved steadily since the building was put into operation until today the farrowing house is virtually disease-free. Several small management changes have made this possible. One was the closing of the farrowing house to everyone except the operators and the strict use of the disinfectant pan by them. Elimination of bedding in the creep area made it possible to observe the droppings of the young pigs more closely and to diagnose and to start treatment for any ailment as soon as it appears. Turning the sow out to feed and dung reduced the possibility of the pigs picking up disease from the sow's manure. Rigid sanitation has been maintained in cleaning and disinfecting the building between each cycle. Elimination of disease in the farrowing house has been very closely related to management. As the operator has become more familiar with the operation, the disease level has gone down until today it is not costing production efficiency. No difficulty has been encountered with disease in the growing building or in the finishing building, even during the periods of warm weather when the hogs seem to be living in conditions favorable to fostering disease. With a healthy pig coming out of the farrowing house there has been no difficulty in producing a market-weight hog.

What part the second growing building and the six-week rest period play in the freedom from disease in the growing building cannot be determined. Observations indicate that the second growing building and the six-week rest period can be eliminated by proper management, but this is strictly observation, not tried or proven in practice.

This pork production plant has had a high labor efficiency. Until recently it was operated by two men. In addition, they farmed the 173 acres. At present another half-

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. . . Pork Production

(Continued from page 279)

time man has been added, but the beef cattle operation on the farm has been reactivated. Mr. Bailey figures that less than one man-hour of labor is required to produce a 225-lb market hog.

This high labor efficiency has been achieved by the capital investment necessary to provide the facilities required for labor efficiency. The entire plant, including the farrowing house, two growing buildings, the finishing building, the granary, the trailers, the tractor, and all mechanical and electrical equipment necessary represents a capital investment of approximately $47,000. This is the replacement value of the plant. On the basis of the production of 2,400 hogs per year, this is an original investment of slightly under $20.00 per market hog produced per year. If the plant is operated at a production figure of 3,000 hogs per year, the investment per hog produced per year is slightly over $16.00.

This cooperative project has been successful in achieving its objectives. It has demonstrated that it is possible and economically feasible to produce pork in a full confinement system at a profit. Mr. Bailey has the efficient pork production plant which he wanted. The pork production plant is owned and controlled entirely by Mr. Bailey. Douglas Fir Plywood Association has no interest in the plant, other than a promotional interest in the material of construction.

This plant is one way of producing pork in a confinement system. It is not the only way or necessarily the best way. This plant is based on our thinking and knowledge in 1956. Already some changes have been made to apply later findings. Basically, however, it would be very little different if it were designed today to fit the same system of management. We are well pleased with the efficiency of production. However, among the thousands of visitors to this farm, there is yet to be found one who would not change the system of management in some detail so as to require a change in buildings and equipment. The operation of this plant has added materially to our knowledge of the buildings and equipment required for efficient pork production.

. . . Hydraulic Conductivity

(Continued from page 273)

tests should be conducted at alternate sites, staggering the sites on each line. Additional tests should be made if there is any doubt about the proper drain location and spacing, as indicated by the field permeability data and the water table contours.

One improvement for conducting the test is to install the electric measuring tape on a swivel to permit it to be swung out of the way during bailing, and then back into the proper position immediately after bailing is completed.

In unstable soils, a perforated downspout pipe with approximately sixty ⅛ in. x 1 in. slots per foot can be used to maintain the hole. Tests in light and medium textured stable soils with and without casings indicated the perforated downspout pipe caused little restriction to the water moving into the hole. When the saturated soil is very unstable, the downspout pipe should be driven into the soil a short distance and the soil augered or bailed out. This driving and augering should be continued until the desired depth is reached. After a burlap sack has been pushed to the bottom of the pipe, the hole can be filled with water and bailed to clean the pipe. On one project the soil had a permeability of from 0.30 to 0.50 in. per hour when the perforated pipe was installed in this manner, but when the hole was augered the entire depth, the downspout pushed to the bottom, and the muck bailed out, the permeability dropped to 0.05 to 0.10 in. per hour.

Summary

Glenn O. Schwab
Member ASAE

Of all the physical measurements for determining the depth and spacing of drain tile, soil hydraulic conductivity is one of the most important, yet one of the most difficult to measure. It is a direct measure of the rate of water movement through a soil, and therefore it is universally applicable to any soil. Because researchers employ different methods of measurement and also different procedures and equipment for the same method, comparison of results are often not possible. Most researchers agree that no one method is suitable for all conditions and that more accurate and practical methods still need to be developed or present methods improved. The committee desires to promote and encourage further research on this subject.

As a followup of this symposium the Drainage Research Committee is studying the various hydraulic conductivity methods to determine the possibility of developing standardized equipment and techniques for each method. Such standards, if developed, need also be acceptable to other technical groups interested in this problem.

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52nd Annual Meeting of ASAE

Cornell University, Ithaca, N. Y. June 21-24, 1959

The 52nd Annual Meeting of ASAE will be held June 21-24 at the New York State College of Agriculture on the Cornell University campus in Ithaca — heart of the famous Finger Lakes vacation spot and one of the nation's leading dairy areas. In addition to the technical program, Cornell engineers have planned a daily series of entertainment and tours. Wives and children will be entertained with special programs during the four-day stay.

Among the high lights of the program will be a Sunday evening opening get-together and buffet dinner; the Monday evening barbecue at Taughannock State Park; the tours scheduled for Tuesday afternoon; FEI Student Dinner Tuesday evening; and the special awards and entertainment program on Wednesday evening.

Advance registration cards and hotel reservation forms have been mailed to ASAE members. Non-members interested in attending the meeting should communicate with the central office of the Society at St. Joseph, Mich., for information on accommodations and the program of the meeting sessions.

General Session

Dr. Byron T. Shaw, administrator of the Agricultural Research Service, USDA, will be featured speaker during the General Session to be held Wednesday afternoon, June 24. C. W. Terry, professor of agricultural engineering, Cornell University, and chairman of the meetings committee will preside during the afternoon session. In addition to the address by Dr. Shaw, presentation of the winning paper in the ASAE student paper award competition will be made, which will be followed by the president's annual address by Dr. E. G. McKibben, director, Agricultural Engineering Research Division, ARS, USDA. The Annual Business Meeting of the Society will conclude the General Session.

Byron T. Shaw

A special program of entertainment has been scheduled in conjunction with the annual awards program on Wednesday evening in lieu of the customery banquet activities. Highlighting this program, which will be held in the air-conditioned Alice Statler Auditorium, will be an address by Karl Butler, farm counselor, AVCO Manufacturing Corp., Ithaca, N. Y. The address will cover interesting sidelights of the visit to Russia by members of a farm mechanization team composed of six ASAE members in the fall of 1958. John McManus, assistant dean, College of Engineering, Cornell University, will be master of ceremonies.

Karl Butler

Power and Machinery Program

The Monday morning session will include two programs. Program A—*Soil Compaction* is a joint session with the Soil and Water group and will include discussions on soil deformation and compaction during piston sinkage by W. H. Soehne, Institute fur Landtechnische, Braunschweig, Germany, W. J. Chancellor and Roy H. Schmidt, University of California; on stress distribution in soils under tire and crawler track loads, by C. A. Reaves and A. W. Cooper, National Tillage Machinery Laboratory; on compaction and slippage effects of forage harvesting machinery, by M. M. Boyd and R. W. Kleis, University of Massachusetts; and on compaction as viewed from the farm by Herbert Stapleton, Shelburne Farms.

Program B—*General* will include discussions on the basic factors affecting the emergence energy of seedlings, by C. T. Morton and W. F. Buchele, Michigan State University; on the plateau profile planter, by J. G. Porterfield, David G. Batchelder, and E. W. Schroeder, Oklahoma State University; on similitude in studies of tillage implement forces, by K. K. Barnes, Iowa State College, C. W. Bockhop, University of Tennessee, and H. E. McLeod, Clemson Agricultural College; and on objective analysis motivates advanced manure spreader design, by C. D. Miller and A. L. Neuhoff, J. I. Case Co.

Papers to be presented during the Monday afternoon session at Program A—*Tractor Tires* will be on pressure distribution between a smooth tire and soil, by G. E. VandenBerg and W. R. Gill, National Tillage Machinery Laboratory; on measurement of soil-tire interface pressure with an instrumentated tire, by G. W. Trabbic, W. F. Buchele, and K. V. Lask, Michigan State University. This session will be concluded with a panel discussion on radial ply tires, by I. F. Reed, National Tillage Machinery Laboratory; P. J. Forrest, U. S. Rubber Co.; T. J. Thaden, Goodyear Tire & Rubber Co.; R. L. Wann, Firestone Tire and Rubber Co.; and Wayne H. Worthington, John Deere Research & Engineering Center.

Papers to be presented at Program B—*Fruit Production* are as follows: "Frost Protection by Wind Machines and Heaters," by F. A. Brooks, University of California; "Some Aspects of Vibratory Fruit Harvesting," by R. B. Fridley, University of California, and P. A. Adrians, USDA; "Mechanization of Fruit Harvest in Michigan—A Progress Report," by S. L. Hedden and J. H. Levin, Michigan State University; "New Developments in Fruit Harvesting and Handling in the Pacific Northwest," by S. W. McBirney, AERD (ARS), USDA; "Progress in Mechanizing Citrus Fruit Harvesting in Florida," by G. E. Coppock and P. J. Jutras, Florida Citrus Experiment Station.

Program A — *Fertilizer Application*, on Tuesday morning, will be a joint session with the National Joint Committee on Fertilizer Application and will cover topics on principles of fertilizer placement (based on a slide set for educational use), by W. L. Nelson, American Potash Institute; on fertilizer placement for small grains, by C. M. Hansen, and L. S. Robertson, Michigan State University, and R. F. Dudley, ARS, USDA; on deep tillage and fertilizer placement in Georgia, by C. E. Rice, University of Georgia; on deep tillage and fertilizer placement in Michigan, by C. M. Hansen, L. S. Robertson, and H. D. Foth, Michigan State University; on the need of precision agricultural equipment for the canning industry, by C. H. Mahoney, National Canners Association; and on physical removal of radioactive surface contamination from agricultural land—a progress report, by R. L. Menzel and Paul James, ARS, USDA.

The Tuesday morning session, Program B—*Economics of Farm Equipment Usage* will consist of discussions on evaluation of factors affecting operating costs of farm equipment, by G. H. Larson, Kansas State College; on optimizing farm tractor design and use—an approach, by K. L. Pfundstein, Ethyl Corp.; on cost and return analysis of crop production machinery size, by D. A. Link and K. K. Barnes, Iowa State College; and on the farmer of 1969, by A. J. Berwick, president, Doane Agricultural Service, Inc.

A. J. Berwick

The Power and Machinery sessions will be concluded on Wednesday morning with two programs. Program A—*Field Hay Curing* will include the following papers: "Drying Rate and Field Loss Comparisons of Hay Harvesting Methods," by M. M. Boyd, University of Massachusetts, with discussions by H. D. Bruhn, University of Wisconsin, and G. R. Sutherland, John Deere Ottumwa Works; "Curing Rates, Field Losses and Feeding Response With Crimped, Rolled and Untreated Hay," R. A. Kepner, J. R. Goss, J. H. Meyer, and L. J. Jones, University of California; "Hay Harvesting in One Day," by T. T. Pedersen, The Royal Veterinary and Agricultural College, Denmark, and W. F. Buchele, Michigan State University, with a discussion by W. K. Kennedy, Cornell University; "Mechanical Dewatering of Forage and Potential Forage Crops," by J. W. Randolph, J. P. Winfree, and V. E. Green, Jr., Florida Everglades Experiment Station.

Program B — *General* will cover discussions on mechanizing the peanut crop in Georgia, by J. L. Shepherd, Georgia Coastal Plain Experiment Station; on machinery and methods of producing and harvesting the Virginia type peanut, by G. B. Duke, ARS, USDA; on farm mechanization in South America, by Roy Bainer, University of California; on evaluation of flame burner design for weed control in cotton, by L. M. Carter and R. F. Colwick, USDA, and J. R. Tavernetti, Agricultural Experiment Station, Davis, Calif., with a discussion by J. L. Smilie and C. H. Thomas, Louisiana State University; and on herbicide application methods and equipment used in cotton, by C. H. Thomas and W. K. Porter, Jr., Louisiana State University.

Soil and Water Program

A joint session of the Soil and Water and the Power and Machinery Divisions on

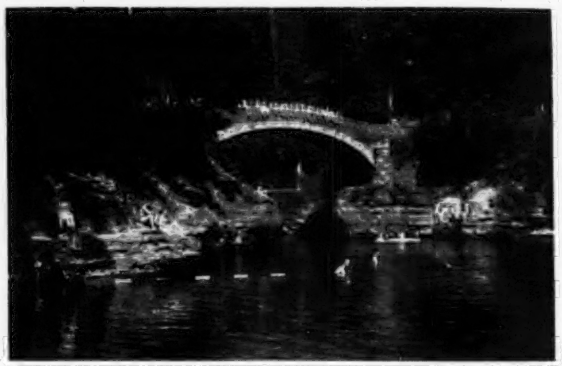
(Continued on page 284)

Cornell University to Serve as Host for ASAE 52nd Annual Meeting, June 21-24

Library Tower, familiar landmark on the Cornell University campus, will serve as guide to ASAE registration headquarters in nearby Willard Straight Hall from which this photo was taken

Willard Straight Hall, center of student activities at Cornell, will be the scene of registration and the evening buffet on Sunday. University Halls (dormitories) are only a short distance away

The Sunday Evening and Wednesday evening programs will be held in Alice Statler Auditorium. Statler Hall houses the School of Hotel Administration which includes a 36-room student-operated hotel



After the Sessions each day, nearby Beebe Lake will attract visitors for swimming and high diving. Water in the stream-fed lake on the edge of the campus will be refreshing in June

Golf Enthusiasts will enjoy the beautiful 18-hole University course. In the background is Moakley House which includes a lounge, restaurant and bar, and quarters for visiting golf teams

Teagle Hall will be headquarters for children 6 to 12 and teenagers. Facilities include a swimming pool, gymnasium, nearby tennis and squash courts and spacious athletic fields

NEW **McCORMICK® NO. 15 FIELD HARVESTER**

Here's big chopping capacity at a price that matches the lowest on the market! Fill the new No. 61 Power-Unloading Box in only 10 minutes!

Chops with the biggest... priced with the lowest!

Here's the leading flywheel-type field harvester—the big McCormick No. 36! It chops over 45 tons of corn silage per hour. Pto or engine drive.

Man, this new McCormick No. 15 really chops fast! It fills a 5-ton forage box in less than 10 minutes. Chops as fast as many field harvesters selling for twice the price of the No. 15. Its price tag matches today's lowest . . . and there's a 60% bonus in chopping capacity in the bargain!

Chop up to 30 tons of grass silage per hour! Dairymen and feeders can green-chop for up to 50 drylot cattle in less than 5 minutes. Big 40 ton capacity of corn silage per hour.

Three brand-new, quick-change harvesting units—60-inch cutter bar, row-crop unit, and 54-inch hay pickup are perfectly matched with the new 6-knife lawnmower-type cutter head for top capacity in any crop.

See it . . . price it . . . you can pay twice as much, but you can't buy higher quality than the durable No. 15 Field Harvester!

INCOME PURCHASE PLAN · PAY AS YOU FARM ·

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See the 1959 forage line at your IH dealer's store. Let him show you how you can buy now . . . pay later . . . and put forage into feedlot or storage at lower cost!

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International Harvester Products pay for themselves in use—Farm Tractors and Equipment . . . Twine . . . Commercial Wheel Tractors . . . Motor Trucks . . . Construction Equipment—General Office, Chicago 1, Illinois.

. . . 52nd Annual Meeting

(Continued from page 281)

soil compaction will be held Monday morning. For details on the subjects to be discussed see Power and Machinery Division, Program A, Monday morning.

On Monday afternoon there will be a joint session also for the Soil and Water Division and the Public Lands and Public Works (Irrigation and Drainage Groups). Five papers will be presented: "Fiber Glass Filters for Tile Drains," by Virgil Overholt, consultant, Hancock Brick and Tile Co.; "Control of Slides by Underdrainage," by N. L. Stoltenberg, 13th Naval District; "Underground Sprinkler Systems," by King Ewing, Ewing Turf Products Co.; "Effects of Surface Loads on Plastic-Lined Mole Drains," by P. L. Manley, ARS, USDA, Cornell University; and "Characterizing Irrigation Water Use by Means of Efficiency Concepts," by Lyman Willardson, ARS, USDA, Utah State University.

Hydrology will be the subject of the discussions when the Soil and Water Division again meets jointly with the Public Lands and Public Works group, on Tuesday morning. This session will include the following topics; "Evaluating Flood Damage Reductions from Proposed Works of Improvement," by F. P. Erichsen, SCS, USDA; "Effect of Vegetative Cover on Water Yields," by J. F. Arnold, Arizona State Land Dept.; "Detecting Deeply Penetrating Rainwater with a Neutron Scattering Moisture Meter," by P. R. Nixon and G. P. Lawless, ARS, USDA.; "Phreatophyte Control," by R. B. Balcom, Bureau of Reclamation, USDI; "Effect of Land Use on Seasonal Water Yields," by D. L. Brakensiek and C. R. Amerman, ARS, USDA.

The concluding session of the Soil and Water Division, on Wednesday morning, will also be held jointly with the Public Lands and Public Works group. This session will cover soil erosion and the discussions will include erosion characteristics of rainfall as measured by soil pans, by G. R. Free and P. L. Manley, ARS, USDA, Cornell University; beach erosion control techniques, by G. M. Watts, Beach Erosion Board, U. S. Army Corps of Engineers; economic evaluation of soil and water management practices, by Mel Cohee, SCS, USDA; laboratory and field studies of canopy inlet tube structures, by R. P. Beasley and E. T. Smerdon, University of Missouri, and L. D. Meyer, ARS, USDA, Purdue University; storm water disposal from elevated sites, by J. C. Scarborough, Post Engineers, Fort Gordon, Ga.

Electric Power and Processing Program

The first session of the Electric Power and Processing Division, on Monday morning, will feature application studies and papers will be presented on farm load studies in New York area, by M. H. Lloyd, Niagara Mohawk Power Corp.; on demand studies on electric house heating, by L. B. Altman, Jr., Iowa State College; on new off-peak load for power suppliers, by W. C. Wenner, Jr., Northwestern Rural Electric Co-op.; on performance comparison of various types of electric, gas, and coal chick brooders, by L. N. Drury University of Georgia; on hot water requirements for dairy farms, by C. N. Turner, Cornell University; on raising the standards on electric house heating, by C. A. Aiken, Iowa Rural Electric Co-op. Assn.; and on electronic flowmeters for measuring milk flow, by R. H. Brown, University of Georgia.

On Monday afternoon the following papers on the topic "Drying" will be presented: "Analysis of Weather Data Pertinent to Crop Drying," by D. B. Brooker, University of Missouri, and J. D. McQuigg, U.S. Weather Bureau; "Determining Available Heat for Hay Drying by Climatological Analysis," by Lewis Schaper and G. W. Isaacs, Purdue University; "Quality Control of Hay," by J. H. Oliver, Aerovent Fan & Equipment, Inc.; "Latest Practices Concerning Drying in Storage with Supplemental Heat," by H. J. Barre, consulting engineer; "Bulk-Curing of Tobacco—An Engineering Advancement," by W. H. Johnson, North Carolina State College; "Effects on Relative Humidity When Drying Air is Heated by Combustible Fuels," by G. M. Petersen, University of Nebraska.

Instrumentation is the theme for the Tuesday morning session and included will be discussions on an instrument for measuring the smut content of wheat, by G. S. Birth, AMS, USDA; on ultrasonic measurement of back-fat of swine, by E. K. Johnson and W. T. Platt, ARS, USDA; on parallel thermocouple circuits and their application to agricultural engineering temperature measurement problems, by H. D. Bowen, North Carolina State College; on investigation of radio-frequency electric fields for stored-grain insect control, by S. O. Nelson, AERD (ARS) USDA, and W. K. Whitney, Kansas State College; on a peanut sheller for grading samples (an application of statistics in design and testing), by J. W. Dickens, AMS, USDA, and D. D. Mason, North Carolina State College; and on theoretical analysis of thermopile sensitivity, by K. A. Jordan, North Carolina State College, and A. C. Dale, Purdue University.

A joint meeting with the Farm Structures Division, on Wednesday morning, will be the concluding session for the Electric Power and Processing Division. The subject to be discussed is environmental control and papers will be presented on chemical scrubbers for control of poultry house atmospheres, by J. W. Zahradnik, J. T. Clayton, and J. E. Steckel, University of Massachusetts; on design factors for air conditioning and ventilating dairy cattle shelters, by R. G. Yeck and M. D. Shanklin, AERD (ARS) USDA, and R. E. Stewart, University of Missouri; on a digital system for recording temperature and humidity by L. L. Boyd, Cornell University; on thermal radiation exchange factors between a cow and her surroundings, by R. L. Perry and E. P. Speck, University of California; and on the effect growth on surface temperature of dairy calves at 50 F and 80 F environmental temperatures, by R. E. Stewart, University of Missouri, M. D. Shanklin, and R. G. Yeck, AERD (ARS) USDA.

Farm Structures Program

The theme of the Monday morning session of the Farm Structures Division is new developments in design. The following topics will be presented: "What We Found Out About Planning Buildings and Equipment," by Russell Larson, AERD (ARS) USDA, University of Minnesota, Thayer Cleaver, AERD (ARS) USDA, University of California and Harry Eby, AERD (ARS) USDA, Plant Industry Station; "Umbrella-Type Farm Shelter," by G. W. A. Mahoney and G. L. Nelson, Oklahoma State University; "A Shelter to Resist Effects of Nuclear Weapons," by Lawrence Collins, Civil and Defense Mobilization, Battle Creek, Mich.; "Problems in Collecting and Processing Livestock Manures," by S. A. Hart, University of California; "A Poultry House for 1970," by D. C. Sprague, GLF Farm Supplies; and "How to Handle Livestock—A Problem With Larger Herd Sizes," by Arthur Schulz, North Dakota Agricultural College.

Farm building design and construction will be covered in the Monday afternoon session and discussions will be given on re-examination of rural waste disposal recommendations, by George Amundson, consultant to Michigan Vitrified Tile Co.; on the development of a packaged poultry house, by M. L. Esmay, Michigan State University; on design of nailed and glued plywood gussets for lumber in rigid frames, by J. O. Curtis, University of Illinois; on stability of wood and steel pole foundations, by H. T. Hurst and J. P. H. Mason, Jr., Virginia Polytechnic Institute; and on development of a new steel farm building, by A. F. Nystrom, Inland Steel Products Co.; on a new farm plan service, by H. J. Barre, consulting agricultural engineer; on the strength of rafter-to-pole joints for pole buildings as affected by type of fastener, number of fasteners, and method of installation of fasteners, by J. N. Walker, Purdue University; and on an evaluation of truss design and sidewall anchorage, by H. T. Barr, Louisiana State University.

Covering the theme, crop conditioning, the Tuesday morning session will feature papers on a new analysis of batch grain dryer performance, by G. L. Nelson, Oklahoma State University; on moisture effect on granular friction of small grain, by R. T. Lorenzen, Colorado State University; on potato storage, ventilation and air circulation systems, by R. S. Claycomb, consulting agricultural engineer; and on storing and feeding high moisture shelled corn from conventional silos, by E. L. Hansen, University of Illinois. Also to be presented at this session on the topic "farm structures recruitment" will be a paper entitled "A Positive Approach to Effective Recruitment of Students in Farm Structures," by F. B. Lanham, University of Illinois. In connection with the theme "farm fence construction" there will be also a discussion on tightening end and corner post brace wires, by P. G. Strom, American Steel and Wire Division; and on effect of temperature on tightness of fences, by J. D. Wilson, Oliver Corp., and J. S. Boyd, Michigan State University.

The closing session of the Farm Structures Division will be held jointly with the Electric Power and Processing Division. For details on the subjects to be discussed see the Electric Power and Processing Division Wednesday morning program.

Special Programs

Details concerning the special programs for the Public Lands and Public Works group, the Extension Seminar, and the Student Members of ASAE will be carried in the June issue of AGRICULTURAL ENGINEERING. Copies of the 52nd Annual Meeting program, containing details of the special programs, are available by writing to ASAE, 420 Main St., St. Joseph, Mich.

BULLETIN

Word has been received from the Committee on Instrumentation and Controls that only a few entries have been received for the instrumentation exhibit planned for the Annual Meeting of ASAE. Persons desiring to enter exhibits are requested to contact Gerald S. Birth, 105A South Wing Administration Building, Plant Industry Station, Beltsville, Md.

For details concerning the Extension Exhibits, see page 220, April issue of AGRICULTURAL ENGINEERING, or write E. D. Markwardt, Chairman ASAE Committee on Extension, Cornell University, Ithaca, N. Y.

It's economical to design with concrete

Sound structural design demands a proper balance between cost and service life. Durability often justifies a greater first cost. But in many cases, it's achieved at no added cost by use of proper design principles.

This is the second of a series of reports showing design techniques with concrete applied to specific parts of a building. The paragraphs that follow tell how to design low-cost, durable concrete floors and paving.

Floors and Paving . . . "to be without costs more"

"A farmer pays for a paved feedlot whether he has it or not. And if he operates without one for many years, he may pay for it several times," said a midwestern cattle feeder. In this case, as in many others, the low-cost solution—leaving the barnyard unpaved—is really the most costly in the long run.

By following the design principles outlined below, engineers can achieve true low cost and at the same time assure a long-lasting paving job.

Slab Thickness: The thickness to use depends on the magnitude and frequency of loads. Fig. 2 shows the slab thickness needed for various wheel loads. The wheel loads shown can be carried for an unlimited number of repetitions. Larger loads can be carried with less frequency.

Jointing: Properly placed and constructed joints relieve stresses in the paving and prevent formation of irregular cracks. Concrete should be placed in longitudinal strips about 10 feet wide. Tongue and groove joints between strips transfer load from one to the other and prevent unequal displacement. Dummy grooves should be cut across the strips at 15- to 25-foot intervals. The grooves are made one-fourth the depth of the slab. Grooves may be cut in the fresh concrete or sawed soon after the concrete has set. A crack forms at the weakened plane, and the irregular faces of the crack transfer the load from one slab of concrete to the other.

At the edge of the paving the absence of an adjacent slab reduces the load-carrying capacity. For that reason, edges where vehicles come onto the pavement should be thickened by 2 inches. Where concrete abuts a permanent structure, an expansion joint is used to prevent stress buildup in the structure.

Reinforcement: Reinforcing steel, when provided in an amount within the range of practical economy, does not increase the flexural strength of the paving. *Where slabs are joined in a manner to control cracking, reinforcement has no function. On farm jobs, it is generally more economical to provide joints as described above and eliminate the reinforcement.* If steel is used, its function is to hold together the fractured faces of slabs after cracks have formed. The amount of steel for this purpose can be determined from the formula:

$$A_s = \frac{9.37\ tL}{f_s} \text{ where}$$

A_S is the steel area per foot of width or length of slab

L is the distance in feet between joints in the corresponding direction

t is the concrete thickness in inches

f_S is the allowable working stress in the steel

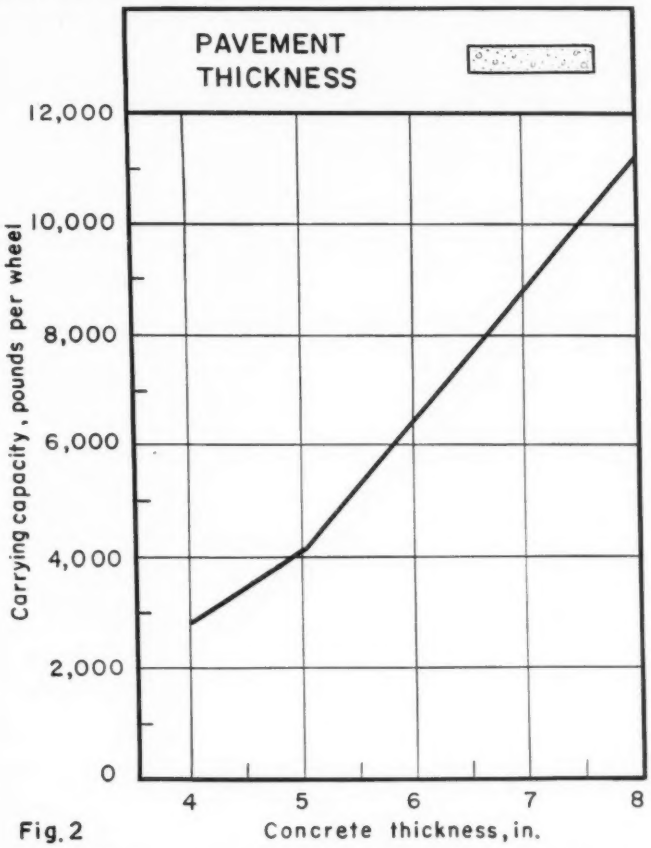


Fig. 2

Quality Concrete: Farm paving is exposed to wide variations in temperature and moisture. In addition, it is subject to severe abrasion and sometimes chemical attack. The concrete should contain approximately 6 sacks of portland cement per cubic yard and should have a maximum water cement ratio of 6 gallons of water per sack of cement. Air-entrained concrete is recommended.

For more information on farm paving, write for the free booklet, "*Pave Your Barnyard with Concrete.*" Distributed only in the United States and Canada.

PORTLAND CEMENT ASSOCIATION
Dept. A5-1, 33 West Grand Ave., Chicago 10, Illinois
A national organization to improve and extend the uses of concrete

Sherwood S. DeForest, former associate editor of the *Successful Farming* magazine, has accepted an appointment as a development representative for United States Steel Corp. In his new position he will be assigned to the agricultural extension section in charge of developments for new applications of steel products to improve farm efficiency. He is an agricultural engineering graduate of Iowa State College where he served as instructor while working on an M.S. degree. He has been a member of ASAE since 1944 and currently is chairman of the Farm Structures Division.

John H. Wessman has accepted a position as director of activities of the Midwest Feed Manufacturers' Association, Kansas City, Mo., and its annual Feed Production School. In his new position he will conduct seminars, coordinate committee work, act as liaison with other groups in the field, work with colleges on mutual problems in the manufacturing of feed and supervise various research projects. One of the association's biggest activities is the annual Feed Production School, scheduled this year at Hotel Continental, Kansas City, Mo., September 23-25.

S. S. DeForest

J. H. Wessman

L. F. Whitney

L. F. Whitney has been appointed to the staff of the University of Massachusetts as assistant professor of agricultural engineering. He received a BSAE degree from the University of Maine in 1949 and took a graduate assistantship at Michigan State University from where he received an M.S. degree in agricultural engineering in 1951. After graduation he took a position as design and development engineer with Ariens Co. of Brillion, Wis. Recently he had been employed as assistant chief engineer with Wirthmore Feeds Inc.

Jack L. Sparks, formerly with the Western Division of Design and Construction, National Park Service at San Francisco, Calif., has accepted a two-year assignment in Haiti for the International Cooperation Administration, USOM. He will serve as technical advisor to the department of agriculture on problems relating to water resources—irrigation, drainage and soil conservation.

Norman J. Kraeft, WGN and WGN-TV farm service director, was presented with a certificate of "honorable mention" April 22 for his entry in the first annual animal agriculture award for farm directors sponsored by the American Feed Manufacturers Association. The certificate was presented by officials of the association at their 1959 annual convention in Chicago.

Receiving one of the two "honorable mention" certificates in the competition, he becomes one of the three top farm directors in the nation recognized for their promotion of animal agriculture in the United States.

Ralph W. Hansen, who was granted a Fulbright Fellowship for 1958-1959 to be visiting lecturer in agricultural engineering at the University of Helsinki, Finland, will return to Colorado State University late in May.

Joseph P. Collopy, formerly chief engineer, Collopy Electro-Soil Co., has opened a consulting engineering office in Fort Collins, Colo., with Thorwald H. Sackett. They are specializing in drainage, land development and problems pertaining to irrigation systems including cathodic protection against corrosion.

W. J. Ridout, Jr. and **Karl H. Gorham** were recently advanced to new responsibilities in the organization of *Electricity-on-the-Farm Magazine*. Mr. Ridout, editorial director since 1956, has been named general manager of the publication. Mr. Gorham's title and duties have been broadened from business manager to advertising and business manager. Jim Ridout, vice-president of ASAE, is an agricultural engineering graduate of Virginia Polytechnic Institute with 20 years of well-rounded experience in farm electrification. He has been with the publication since 1950, when he became its editor. In his new position he will also continue as editorial director. Karl Gorham has been connected with the business side of the publication since it started in 1927, and is credited with major contributions to its continued growth. In his new capacity he will be responsible for all advertising and circulation activities.

George A. Crabb, Jr., has recently accepted a USOM overseas assignment to Sudan where he will be connected with a program to assist in the establishing of a sound educational program in that country. He will serve in the capacity of an educational advisor to the hydraulic and hydrologic training program and will also assist with technical training in surveying and mapping.

NECROLOGY

Austin W. Zingg, chief, Watershed Technology Research Branch, ARS, USDA, Beltsville, Md., died in Fort Collins, Colo. on April 7. He was born in Winfield, Iowa, in 1906 and received a B.S. degree in agricultural engineering from Iowa State College in 1930. He pursued graduate studies intermittently at Iowa State College, Colorado State University, Kansas State College, University of Missouri, and received an M.S. degree from Kansas State College in 1952. He entered Federal service with USDA in 1934, beginning his career in soil and water conservation research at Bethany, Mo. For later assignments he lived in Columbia, Mo.; Manhattan, Kans.; Fort Collins, Colo., and in the Washington, D. C. area.

A. W. Zingg

He attained international reputation in the field of erosion control, being an authority on the mechanics and control of both wind and water erosion. Similarly, he was an authority in the field of agricultural hydrology and served with distinction in the organization and administration of watershed research in ARS which was his assignment at the time of his death. He was a registered professional engineer in the state of Missouri and a member also of American Geophysical Union, American Society of Agronomy, Soil Science Society of America, Western Society Soil Science, Soil Conservation Society of America, Sigma Xi, Gamma Sigma Delta, and Phi Kappa Phi.

He is survived by his wife, Bernice, a son, Lawrence and a daughter, Virginia.

EVENTS CALENDAR

May 18-20 — *Fifth Annual Symposium on Instrumental Methods of Analysis,* Shamrock-Hilton Hotel, Houston, Texas. Apply to Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

May 25-28 — *Design Engineering Conference,* Convention Hall, Philadelphia, Pa., sponsored by machine design division of ASME. Further information can be obtained from Banner & Greif, 369 Lexington Ave., New York 17, N. Y.

May 29 - June 7, 1959 — *RiLa* arranged by Swedish Federation of County Agricultural Societies and billed to be the largest agricultural show to be held in Sweden since 1946. Its aim is to give presentation of Sweden's mechanized farming and high-quality livestock breeding, and also the country's agriculture as an export-import industry. Further details may be obtained from The Swedish-International Press Bureau, Brunkebergstorg 14, Stockholm, Sweden.

May 31—June 5 — *Annual Industrial Research Conference,* Arden House, Columbia University Harriman Campus, New York. For information write M. F. Garvey, Dept. of Industrial and Management Engineering, School of Engineering, Dept. of Industrial and Management Engineering, Columbia University, New York, N.Y.

June 9-13—*Second Inter American Food Congress,* Carillon Hotel, Miami Beach, Fla. For more information write Inter American Food Institute, 1015 Metropolitan Bank Bldg., Miami, Fla.

June 22-26 — *American Society for Testing Materials* and the *American Society for Engineering Education Symposium on Education in Materials,* Atlantic City, N. J. For details contact American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

One in a series of technical reports by Bower

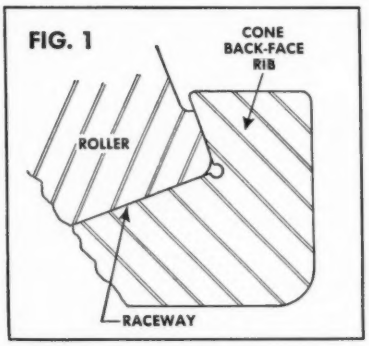
BEARING BRIEFINGS

BEARING GEOMETRY MAKES OR BREAKS BEARING PERFORMANCE

To develop high capacity and optimum performance in a tapered roller bearing, it is essential that roller alignment be accurate. Correct roller alignment, in turn, depends on a critical geometric relationship between the cone back-face rib, and the cone raceway.

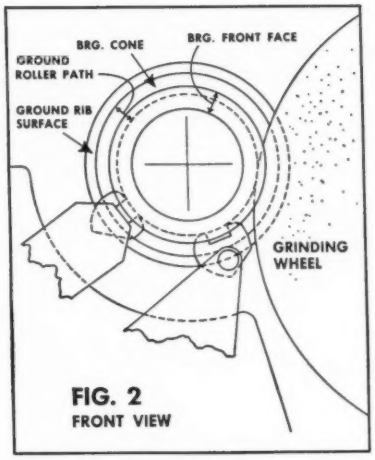
Perfection in this geometric relationship compels the rollers to align themselves perfectly with respect to the bearing geometry, and each roller shares equally in the work that is imposed. Figure 1 diagrams the important elements involved.

When this rib-to-raceway relationship is incorrect (because of either faulty bearing design or manufacturing inaccuracies), rollers experience misalignment and begin to skid and skew under



load. As engineers know, poor performance and premature bearing failure are inevitable under these conditions.

In the design and manufacture of Bower tapered roller bearings, Bower engineers take great care to generate and hold an exact face angle on the cone back-face rib. In practice, this means that Bower



bearings are designed for maximum life and optimum performance under any operating conditions. It means that Bower bearings retain accurate roller alignment under all speeds and loads up to the maximum for which the bearing is rated.

It's one thing to develop proper bearing design on paper, but quite another to carry it out consistently in manufacture. To this end, Bower engineers were instrumental in the design and development of a unique centerless grinder on which Bower precision grinds each bearing's cone raceway and rib-face simultaneously. The results obtained from these machines invariably meet or surpass Bower's exacting requirements and assure perfect roller alignment.

Figures 2 and 3 are front and side views which illustrate Bower's technique of centerless grinding rib-faces and cone raceways together. As a result, every component in a Bower bearing is perfectly concentric about its rolling axis.

★ ★ ★ ★

When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION — FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN

Chicago Section

The Chicago Section will meet May 13 at the Western Society of Engineers, 84 East Randolph St. A roast beef dinner will be served at 5:30. The showing of the new film, "Dynamic Careers Through Agriculture" will add interest to the program and will precede the panel discussion on the role of the Section in promoting interest in agricultural engineering as a career. Members of the panel will include representatives from the National Society, the local Section, a professional public relations firm, and a recent graduate in agricultural engineering. The program will conclude with a feature entitled "Operation Feedbunk."

Michigan and Ohio Sections

New officers for the Michigan and Ohio Sections were announced at a joint meeting of the two sections April 10 and 11. They are as follows: **Michigan Section** — chairman, H. C. Wolsey, chief engineer, Battle Creek Works, Oliver Corp.; vice-chairmen, J. H. Oliver, sales promotion manager, Aerovent Fan & Equipment, Lansing, H. M. Gitlin, research department, Tractor and Implement Division, Ford Motor Co., and W. A. Cutler, extension specialist in agricultural engineering, Michigan State University, East Lansing; secretary-treasurer, J. S. Boyd, professor, agricultural engineering, Michigan State University, East Lansing; nominating committee, E. H. Kidder, E. D. Anderson and K. L. Pfundstein. **Ohio Section** — chairman, C. L. Hahn, agricultural engineer, Ohio Division of Water, Columbus; vice-chairman, H. J. Barre, consulting engineer, Mansfield, and secretary-treasurer, G. O. Schwab, professor, agricultural engineering, Ohio State University, Columbus.

Central Illinois Section

The Spring Meeting of the Central Illinois Section was held at the Latzer Hall, University YMCA, Champaign, Ill., April 1, 1959, with an attendance at the dinner meeting of 64. Dr. E. G. McKibben, Director, AERD, ARS, USDA, and president of ASAE, who was the principal speaker, discussed agriculture and agricultural engineers. Officers elected for the coming year are: chairman, A. R. Ayers, owner, Central Illinois Mfg. Co., Bement; vice-chairmen, K. E. Fuller, general manager, Fuller Seed Co., Lincoln, E. F. Randolph, field engineer, Caterpillar Tractor Co., Peoria, and J. H. McCavitt, irrigation engineer, Rainy Sprinkler Sales, Peoria; secretary-treasurer, G. C. Shove, associate professor, agricultural engineering department, University of Illinois, Urbana; nominating committee, C. A. Kincaid, agricultural field engineer, Portland Cement Association, Champaign, L. G. Reeser, sales manager, Mexican-Caribbean Division, Caterpillar Tractor Co., Peoria, and J. H. Thomas, rural sales director, Central Illinois Light Co., Peoria.

Alabama Section

The Alabama Section held a two-day meeting in Anniston, April 23-24 with engineering aspects of soil and water control as the central theme.

Papers presented during the first day covered topics on soil and water control.

The Thursday morning session consisted of a tour of the Central Electric Tube Plant at Oxford. E. C. Easter, vice-president, retired, of Alabama Power Co., discussed opportunities for agricultural engineers at a luncheon meeting. Upon completion of his address, Mr. Easter's many friends presented him with a portrait of himself. This portrait is to be on permanent display in the agricultural engineering building, Alabama Polytechnic Institute, in recognition of Mr. Easter's outstanding work and contributions to the field of agricultural engineering.

"Inches from Starvation" was the title of the first paper presented by Kermit Tucker, manager of research farm, Alabama Flour Mills. C. C. Mullen, president, Rome Plow Co., discussed land clearing. Two papers on the overall aspects of the small watershed program and design of small watershed structural measures followed, by Julian Brown, executive secretary, State Soil Conservation Committee, and Sam Richbourg, design engineer, Soil Conservation Service, respectively.

On Friday, the design of a new transmission developed by Ford Motor Co. for farm tractors which permits the tractor operator to change speeds with finger-tip control was discussed by R. L. Erwin, manager of engineering administration and services department, Ford Motor Co.; T. L. Ingram, division rural service engineer with Alabama Power Co., discussed the use of heat pumps in poultry houses, and E. I. Hatch, executive vice-president, Alabama Power Co., presented a history of the development of Coosa River and discussed the 10-year development plans now underway by Alabama Power Co. on the Coosa. Dale H. Arner, biologist, Soil Conservation Service, related wildlife conservation to soil and water conservation in his presentation, and F. A. Kummer, head, department of agricultural engineering, API, brought the group up to date on curriculum changes in the courses for undergraduates and also discussed the recently introduced doctoral program in agricultural engineering at API.

The fall meeting of the Section was announced for October 22-23, to be held in Enterprise.

Florida Section

A field trip, dinner program, technical program and business session were included in the Sixth Annual Meeting of the Florida Section. The meeting was held at West Palm Beach, April 16-18. Registration and a social hour opened the meeting, Thursday evening, April 16.

A visit to the unique Everglades agricultural area occupied most of Friday, April 17. It was preceded by a welcome by M. P.

(Continued on page 290)

ASAE MEETINGS CALENDAR

May 13 — CHICAGO SECTION, Western Society of Engineers, 84 E. Randolph St., Chicago.

JUNE 21-24 — 52ND ANNUAL MEETING, Cornell University, Ithaca, N. Y.

September 1-3 — NORTH ATLANTIC SECTION, University of Maryland, College Park, Md.

October 14-17 — PACIFIC NORTHWEST SECTION, Ephrata, Wash.

October 22-23 — ALABAMA SECTION, Enterprise, Ala.

December 16-18 — WINTER MEETING, Palmer House, Chicago, Ill.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

New officers for the Michigan Section are: *(Seated, left to right)* **J. S. Boyd, secretary-treasurer, and H. C. Wolsey, chairman;** *(standing, left to right)* **W. A. Cutler, J. H. Oliver and H. M. Gitlin, vice-chairmen**

New officers for the Alabama Section are: *(left to right)* **J. T. Gaillard, secretary-treasurer; A. W. Cooper, out-going chairman; Neal McGough, new chairman; and T. E. Corley, vice-chairman**

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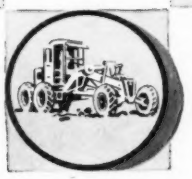


Agricultural Engineering on ASEE Program

The Agricultural Engineering Division of the American Society for Engineering Education has scheduled a half-day session during the 67th Annual Meeting of the ASEE, to be held June 15-19 at the University of Pittsburgh. G. E. Spencer, ASAE representative on the ASEE general council, will preside at a luncheon to be held at 12:00 noon, Thursday, June 18. The program will begin at 2:00 p.m. with G. E. Pickard, University of Illinois, presiding. Addresses will include discussions on a course in land locomotion mechanics by E. T. Vincent, University of Michigan and the changing place of the laboratory in engineering education by D. R. Hunt, Iowa State College. To complete the program the gifted student will be the topic for discussion. Responsibilities of the College will be covered by J. W. Cohen, director of Inter-university Committee on the Superior Student, University of Colorado, and Industry's Use of Him will be discussed by E. H. Case, director of College and University Relations, Deere and Company.

On Monday morning, June 15, the Agricultural Engineering Division will have a jointly sponsored meeting with the electrical, aeronautical, architectural, chemical, civil, industrial, mechanical and mineral engineering divisions on the general subject of teaching electrical engineering science courses for non-electrical students. Also, Wednesday is to be given over completely to tours of the Pittsburgh area arranged by the local arrangements group. The program was developed by F. B. Lanham, chairman of the Agricultural Engineering Division of ASEE.

AE Day at Kansas

An Agricultural Engineering Day and open house will be held at Kansas State University May 16 for the purpose of inspecting the new agricultural engineering facilities. The morning program will be preceded by a display and demonstration in the new agricultural engineering wing and a tractor pulling contest in the agricultural engineering court. G. H. Larson, head, agricultural engineering department, Kansas State University, will preside at the program which will feature addresses by G. H. Beck, director of the Kansas Agricultural Experiment Station and E. L. Barger of Massey-Ferguson Co. The unveiling of a portrait of Professor F. C. Fenton will conclude the morning session.

Demonstrations to be held in the afternoon in the agricultural engineering court will include a radio-controlled electronic tractor guidance system; a gasoline, diesel, and liquefied-petroleum tractor fuel contest, and a tractor upset safety demonstration.

New SAAE and VA Officers

The Annual Meeting of the Southern Association of Agricultural Engineering and Vocational Agriculture was held April 22 and 23 at the Atlantan Hotel, Atlanta, Ga. The new officers have been announced as follows: president, T. G. Walters, state supervisor of vocational agriculture, Ga.; vice-president, A. W. Snell, head, agricultural engineering department, Clemson Agricultural College, South Carolina; secretary, G. G. Powell, farm mechanics technician, Mississippi State Office of Education, and fiscal officer, C. C. Scarborough, head teacher trainer, North Carolina State College.

AE Students Vie for Engineering Award

Two Colorado State University agricultural engineering students, Andrew M. Brown and Vincent V. Salomonson, were named among the three finalists for the CSU Honor Engineer award, a silver medal, the highest honor bestowed a senior engineering student. Andrew Brown is editor of "The Slide Rule," CSU engineering publication; president of the Colorado Student Branch of ASAE; member of Sigma Tau, engineering honor society; Pi Delta Epsilon, journalism honor society; Phi Delta Theta, social fraternity; and engineering legislature. Vincent Salomonson recently received top award for a paper presented at a meeting of the Rocky Mountain Section of ASAE in Logan, Utah, and is affiliated with Sigma Tau, engineering honor society; Kappa Mu Epsilon, mathematics honor society; Arnold Air Society; Omicron Delta Kappa, men's leadership society, and A Cappella Choir. Winner will be selected at Engineers' banquet May 22.

CORRECTION

Attention has been called to the omission of two co-authors of a book in the Wiley Ferguson Foundation Agricultural Engineering Series mentioned in a tribute to Harold E. Pinches on page 178 of the April issue of AGRICULTURAL ENGINEERING. In addition to Truman E. Hienton as author of the book, "Electricity in Agricultural Engineering," Dennis E. Wiant and Oral A. Brown should have been listed as co-authors.

. . . With ASAE Sections

(Continued from page 288)

Mounts, agricultural agent, Palm Beach County, and by an illustrated introduction to the Everglades, presented by W. T. Forsee, Jr., chemist-in-charge, Everglades Experiment Station.

The tour featured stops at Pumping Station number 5, a low-lift, 2,000,000-plus gpm diesel-powered water control installation; mechanized field harvesting and packing of sweet corn, radishes, and celery; sugar making operations of the U.S. Sugar Co., Clewiston, from field harvesting through primary refining; and a visit to the Everglades Experiment Station. Lunch was served in the machine shed and shop at the station.

ASAE President E. G. McKibben was the featured speaker on the dinner program Friday evening. He addressed the section on "Challenges to Agricultural Engineers." L. E. Oglesby of the International Harvester Co. at Jacksonville, was toastmaster. R. A. Palmer, assistant secretary and treasurer of ASAE, represented ASAE headquarters.

A technical program Saturday morning offered variety in four 20-minute presentations. They were: "Agricultural Engineering in Florida," by D. T. Kinard, head of the agricultural engineering department, University of Florida; "Florida's Agriculture and Some Related Agricultural Engineering Problems," by Thomas J. Hughes, agricultural news editor, Florida Grower and Rancher; "Low-Cost Plastic Liners for Mole Drains," by Luther C. Hammond, associate professor of soils, University of Florida; and "Mechanical Harvesting of Citrus," by Fred Laswell, inventor and cartoonist.

Nominated and elected to fill section offices for the ensuing year were: D. E. Adams, chairman; S. E. Dowling, H. C. Nelson, and R. E. Hellwig, vice-chairmen; E. S. Holmes, secretary; and W. H. Parady, treasurer.

Officers for the 1958-59 year, who arranged and handled the meeting, were D. S. Harrison, chairman; D. E. Adams, M. H. Byrom, and R. E. Choate, vice-chairmen; H. C. Nelson, treasurer; and S. E. Dowling, secretary. Other South Florida members who served as hosts for the meeting and field trip are U. S. Allison, D. H. Bell, B. C. Beville, W. L. Brantley, H. Q. Day, U. S. Felsing, P. J. Jutras, S. N. Knight, J. T. Pickett, J. W. Randolph, B. F. Sanford, Jr., J. C. Stephens, A. C. Stevens, C. D. Susman, H. Weaver, G. H. Wedgworth and H. D. Whittemore.

Oklahoma Section

The Oklahoma Section will hold its annual spring meeting in Oklahoma City on May 25 and 26, concurrently with a statewide meeting of the Oklahoma Conservation Contractors.

Presiding at the Monday morning session will be C. V. Phagan, ext. engr., Oklahoma State University. W. T. Burtschi, state cons. engr., SCS, will discuss specifications of land treatment practices in Oklahoma. Other topics to be presented are: "Telling Your Story," "Oklahoma Association of Soil Conservation Districts—Their Program and Why You Should Know," and "A Review of the Agricultural Conservation Program in Oklahoma." Presiding at the Monday afternoon session will be D. W. Turnbull, district rep., Caterpillar Tractor Co. This session will include discussions on a complete conservation plan for farms and ranches in Oklahoma; on construction of detention dams; and on planning for a profit by knowing your costs.

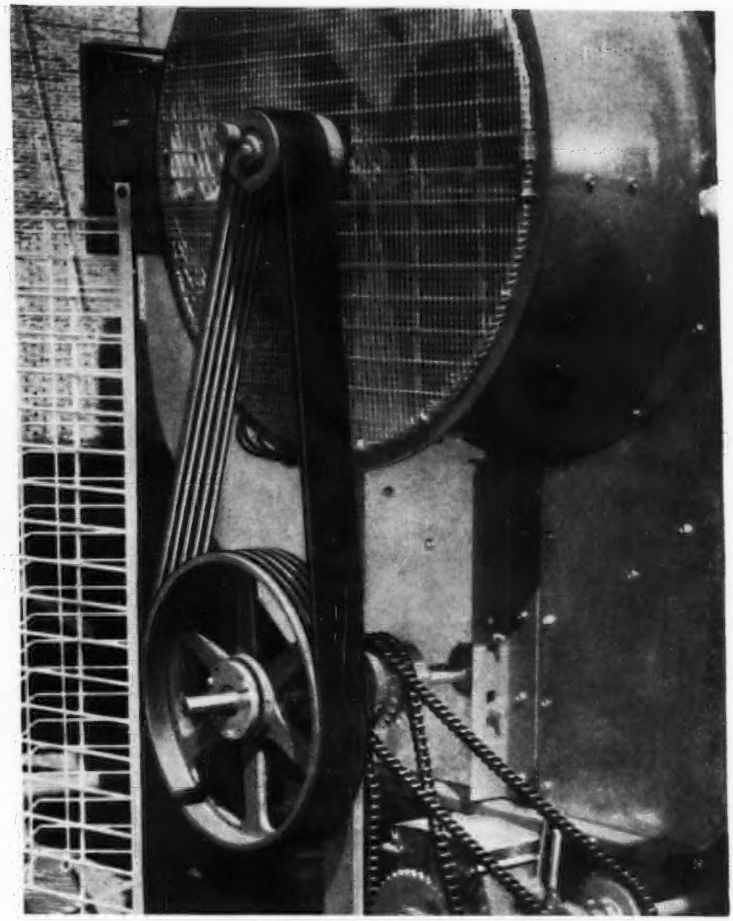
E. W. Schroeder, head of agricultural engineering, Oklahoma State University, will preside at the Tuesday morning session, at which time F. V. Van Allen, International Harvester Co., will speak on bidding watershed earthmoving jobs. A representative of the Kansas Conservation Contractors organization will lead a discussion, and an open session for consideration of forming a state organization will conclude the two-day meeting.

Washington, D.C. Section

The Washington, D.C. Section met May 8 at the South Building, USDA, to see a film of the "Mackinac Bridge Diary," by U.S. Steel, American Bridge Division. The film presented an interesting story of how a suspension bridge is built and covered many highlights of the historical events preceding the erection of the bridge linking Michigan's two peninsulas.

The next meeting of the Section is scheduled for June 12 at Beltsville. Details may be obtained by writing to ASAE, 420 Main St., St. Joseph, Mich.

R/M AGRICULTURAL BELTS *SOLVE EQUIPMENT DRIVE PROBLEMS*



On all types of power applications – for every performance requirement – R/M Agricultural Belts have won the confidence of farm machine and equipment manufacturers. For example, by using R/M's patented Poly-V* Drive on the grain-dryer shown above, Behlen Manufacturing Company was able to eliminate the gear reducer formerly required with a V-belt drive to reduce blower speed. Results? A far less expensive power drive installation, longer belt life . . . substantial reduction of vibration on the blower.

On harvesting machines and similar farm equipment drives, engineered features of strength, flexibility and long life built into Manhattan Agricultural V-Belts and Condor Whipcord Endless Belts also assure the day in, day out drive dependability that really pays off on the job! Manhattan belting engineers draw on more than 60 years of rubber technology and experience to help you make your farm equipment drive as trouble-free as possible.

Let Raybestos-Manhattan work with you to solve your power transmission drive problems . . . and show you how R/M Agricultural Belts add "More Use per Dollar" to the equipment you manufacture.

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ENGINEERED FOR FARM EQUIPMENT DRIVES

- **R/M AGRICULTURAL V-BELTS**
  Write for Bulletin 6868
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MANUFACTURERS' LITERATURE

Literature listed below may be obtained by writing the manufacturer.

Synchronous Generators and Motors

General Electric Co., Schenectady 5, N.Y. — Two 4-page bulletins describe design features, construction and applications of high-speed motors for commercial and industrial use and high-speed synchronous generators for use in airports, construction projects, factories, radio stations, lumber camps, utilities and other industrial, commercial and military applications. Both folders are illustrated showing manufacturing techniques and typical installations.

Single or Three Phase Motor

System Analyzer Corp., Nokomis, Ill. — A 4-page folder, Bulletin 189, which reviews data on the company's Power Twin-Universal motor which operates as a single, two, or three-phase motor. The bulletin details typical applications and operating comparisons.

Screen Area Requirements

Overstrom & Sons, Inc., 2213 W. Mission Rd., Alhambra, Calif. — An 8-page folder which features a new method of estimating screen area requirements. The method is described in seven steps, supplemented with appropriate charts. A sample problem and solution is also included. Other pages in the folder describe various types of the company's equipment, construction and operating features, and applications.

Silo System and Auger Cattle Feeder

James Mfg. Co., Fort Atkinson, Wis. — An 8-page illustrated booklet describing the company's Big Jim silo system. Charts are included which compare the relative features of strip grazing, green chop, and feed storage and the amount of milk produced per acre. Storage-feeding charts also compare silo capacities to the number of tons fed per cow per 360 feeding days. A second, 4-page folder gives information on the company's adjustable "feed flow" auger feeder. Photos and diagrams illustrate use and application.

Dry-Type Air Cleaner Change-Over

Caterpillar Tractor Co., Peoria, Ill. — A 2-page reference describing air cleaners available for Caterpillar-built machines originally equipped with oil bath units. Change-over group numbers for the machines are enumerated by Serial Number classification, along with element service group numbers.

Soil and Water Conservation for Farmers and Contractors

Allis-Chalmers Mfg. Co., Tractor Group, Milwaukee 1, Wis. — Booklet No. TL-2044 explains land treatment practices to increase farm income and save soil and water. The contents describe the various conservation programs and practices now in operation. The layout of this literature piece, utilizing pertinent photographs and sketches, contributes to easy reading and understanding. It will be of great assistance to those who have questions about the work available in soil and water conservation and/or about the government programs prompting increased activity.

Engine Power Consultants

Engine Division, Caterpillar Tractor Co., Peoria, Ill. — Booklet 20186 describes the work of men who act as power consultants on the installation and application of diesel power. It gives case histories of their work and on-the-job reports of typical diesel installations where engine owners were helped to cut costs and increase production.

Big Push in Watershed Work

Allis-Chalmers Manufacturing Co., Construction Machinery Division, Milwaukee, Wis. — The March-April 1959 issue of the "Reporter," external house organ of the division, discusses soil and water conservation and its significance, particularly to earthmoving contractors. Included is a table of statistics on watershed projects and one on the status of watershed applications.

Micro Probe Literature List

Instruments Division, Philips Electronics, Inc., 750 S. Fulton Ave., Mount Vernon, N. Y. — The tabulation of published papers includes 73 articles which have appeared in domestic and foreign publications. Bibliography gives the name of publication, volume number, page numbers and year of publication.

Sprockets and Flexible Couplings

Acme Chain Corp., Holyoke, Mass. — A new illustrated catalog (100B) describing the company's "Grip-Master" stock sprockets and flexible couplings for roller chains, including full dimensions, revised prices, mounting and dismounting instructions, and other engineering data.

Self-Propelled Combines

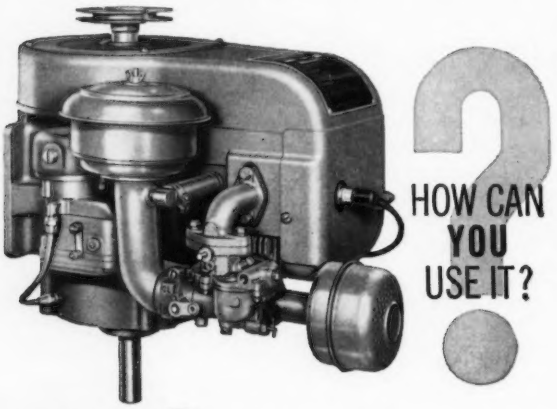
The Oliver Corp., 400 W. Madison St., Chicago 6, Ill. — A 12-page, 2-color folder gives detailed descriptions and specifications for models 35 and 40 self-propelled combines for grain, beans, seeds and corn. Photographs and drawings illustrate the entire working parts of these self-propelled models.

It Could Be Done... so "WISCONSIN" Did It!

Now Presenting the Engine Industry's First Line of **HEAVY-DUTY VERTICAL-SHAFT ENGINES**

The Need: During the past few years, vertical-shaft engines have become a part and parcel of "competitive footballing" in the rotary power-mower field. Because so many of these mowers have been offered at "bargain basement" prices, the quality of the power components had to suffer . . . to the eventual misfortune of the user-customer.

The Remedy: To meet the demand among discriminating original equipment manufacturers for TOP-QUALITY engines to match their machines, "Wisconsin" has developed and now presents the Industry's *first line* of truly HEAVY-DUTY, quality-built vertical-shaft power units, in a highly selective power range. Available in three sizes, rated from 2.5 to 9.2 hp. in a 1600- to 3600-rpm range, these rugged, low-silhouette engines have been designed to meet a broad diversity of applications, delivering higher power and service potential.



All traditional Wisconsin heavy-duty features are incorporated in the design and construction of these new engines. If you are looking for this type of power unit, let Wisconsin engineers help you adapt these engines to your equipment. For a quick briefing on the WISCONSIN Vertical-*Shaft Engine line, write for bulletin S-245.*

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MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

Destruction testing . . . key to the long life

BUILT INTO ALLIS-CHALMERS TRACTORS

Allis-Chalmers tractor components are subjected to exhaustive destruction tests before they receive final approval.

Pictured here, for example, is a giant "tuning fork," especially developed by Allis-Chalmers laboratory technicians. Held between its huge "tines" is a truck wheel for a crawler tractor, which must absorb up to *2,000 vibrations per second* . . . around the clock, for days on end.

Failures due to metal fatigue, which might not develop for years in actual field service, are thus quickly revealed, enabling metallurgists and engineers to make changes in materials or design that will increase toughness and assure longer life.

This pre-determination of quality and performance in vital components is typical of the research that goes on endlessly in Allis-Chalmers engineering laboratories and proving grounds. It's the kind of insurance that farmers are entitled to . . . *and get* . . . when they buy *Allis-Chalmers* farm equipment!

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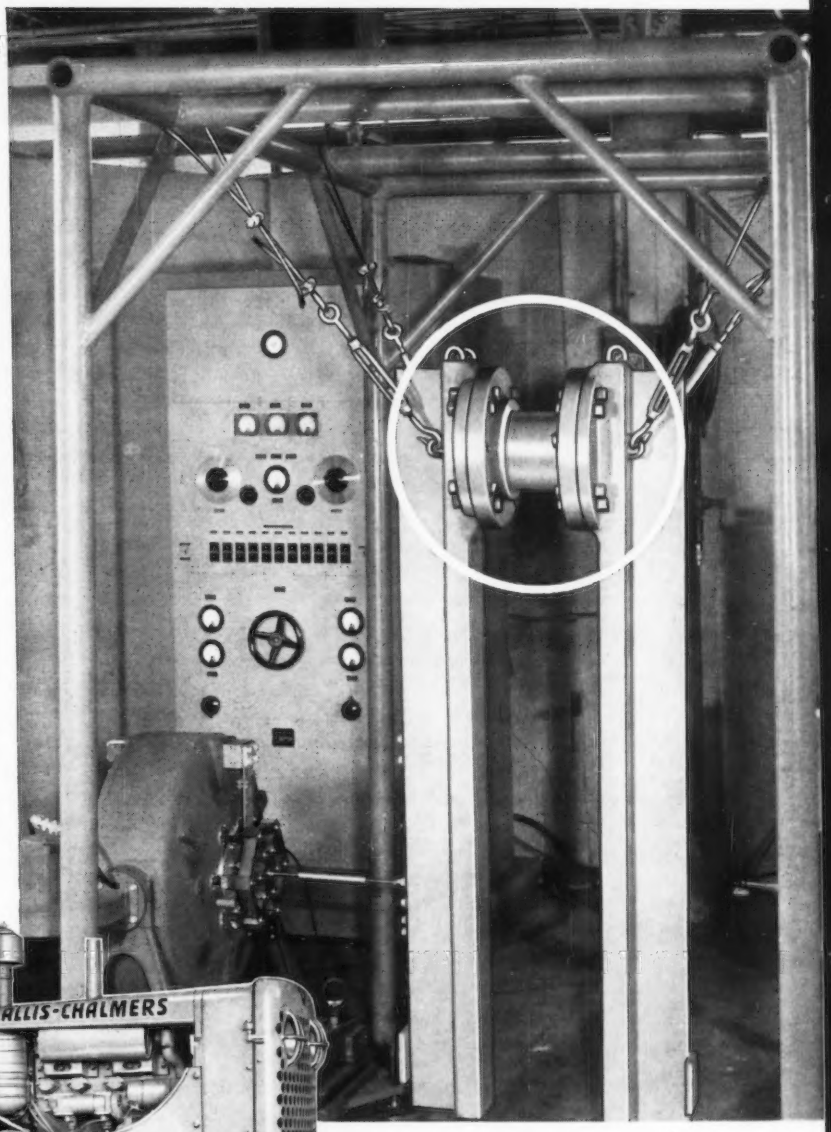
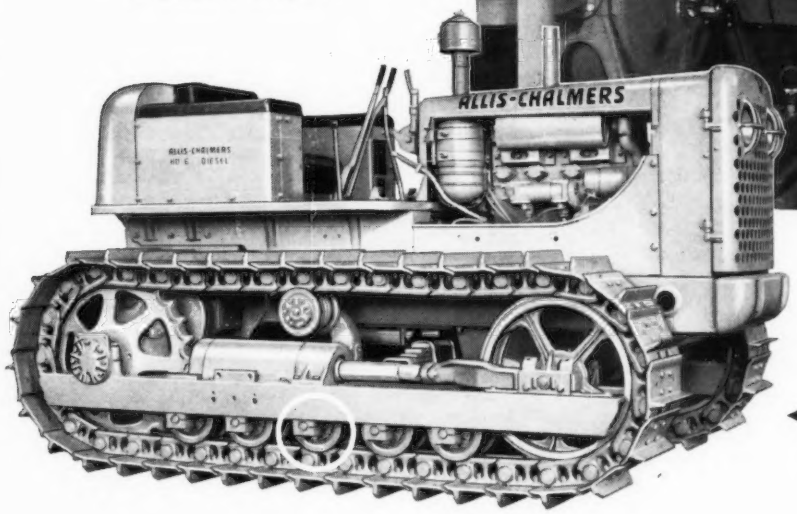


▲ Electronically produced vibrations . . . up to 2,000 per second . . . pre-determine the service life of a truck wheel held between the "tines" of a giant "tuning fork."



◀ No other assemblies are required to absorb the excessive punishment imposed upon the tracks of a crawler tractor in normal service. Destruction testing assures Allis-Chalmers owners of unequaled track performance and long life.

Market trends and farm events of nation-wide interest are brought to farms every Saturday on the National Farm and Home Hour over local NBC outlets.

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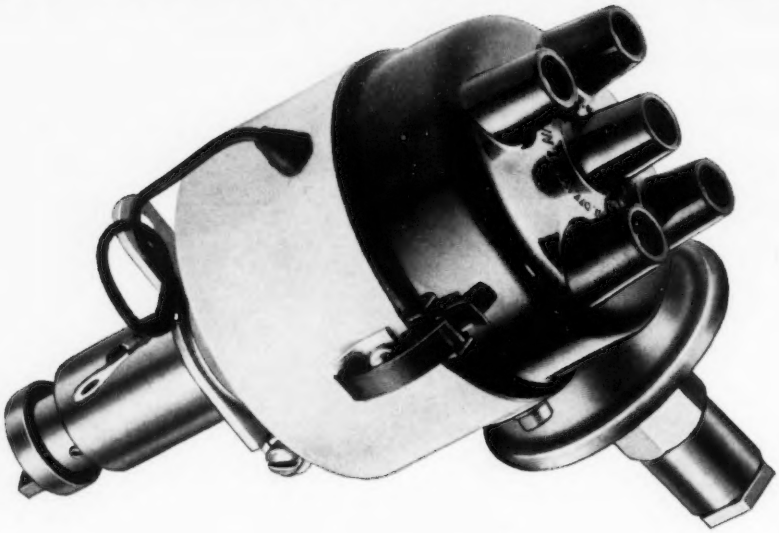
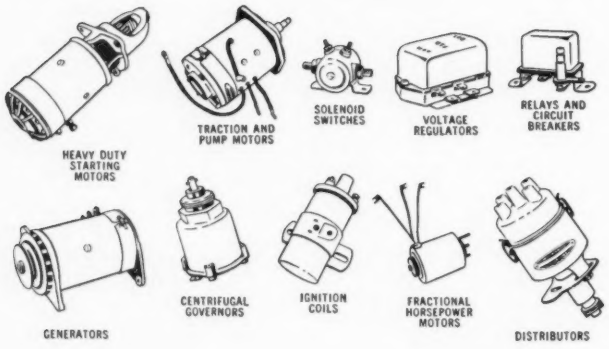
SIX NEW IMPROVEMENTS IN DISTRIBUTOR DESIGN



NEW COST REDUCTION SERVICE FOR MANUFACTURER CUSTOMERS

Programs that include design, engineering, methods, automation and manufacturing are all contributing to the important new cost reduction service of the Electrical Products Group of Auto-Lite. Included are greatly expanded research and engineering activity, facilities for field training and servicing and District Managers prepared to assist customers and prospects in their drive for lower costs.



Now Auto-Lite offers a completely new distributor design. Ignition engineered for 4-, 6- and 8-cylinder automotive and industrial applications, this new, low friction governor distributor is extremely rugged and dependable. Here, for example, are just six of the many advantages of this new distributor:

1. Weight savings of approximately 40% over most other designs
2. Non-corrodible distributor bowl that is salt spray resistant and unaffected by marine and tropical environment
3. Low hysteresis governor advance design for high accuracy of calibration of speed versus spark advance
4. Glass-filled high temperature resin base molded around a powdered iron bearing pedestal
5. Long life lubricated sintered iron cam element and weight element
6. Lubricant capacity six to eight times that of conventional oilers means long life lubrication for the distributor bearings

This unit is available in either vacuum or non-vacuum types and with a variety of precisely engineered seals to prevent penetration of dust, water, or oil.

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All-Plastic Spray Pump

John Bean Division of Food Machinery & Chemical Corp., Lansing, Mich., has developed an all-plastic centrifugal spray pump for use in its 10-gal capacity mobile sprayer for insecticides, liquid fertilizers, and similar agricultural sprays. Powered by a 2¼-hp gasoline engine, the pump can deliver flows of up to 3 gpm at 60 psi. The pump, constructed principally from molded polyester parts, is simple in operation. The impeller, which is coupled directly to the output shaft of the engine, is the only moving part. Major parts of the pump include

a 6½-in. diameter 6-vane impeller, a two-piece housing (consisting of the impeller base and the volute), and the intake tube and are molded from a glass-reinforced low-pressure polyester molding compound. Structural details, such as flanges, rims, bosses and bolt holes are molded in. Self-priming is accomplished by mounting a 1⅛-in. diameter propeller at the lower end of the vertical rod which holds the impeller to the drive shaft. Rotation of the propeller forces the liquid up the intake tube and into the impeller as the engine starts.

Fitting Joins Plastic to Cast Iron Sewer Pipe

Carlon Products Corp., Aurora, Ohio, has introduced a new fitting which enables plumbers to join plastic sewer and drain pipe with cast iron pipe by means of molten lead joints. The new fitting is easily solvent welded to the plastic pipe. Normal

procedure for making a hot lead joint is then followed to obtain a permanent connection with the cast iron. The metal pipe is inserted in the fitting, packed in with oakum and then wrapped with an asbestos rope. The asbestos is firmly clamped in place and the hot lead poured. Final tamping of the lead reportedly provides a tight seal.

New Method for Plant Protection

Plastics Division, Visking, Co., Division of Union Carbide Corp., Fruit Ridge Ave. & Ft. Harrison Rd., Terre Haute, Ind., has announced a new method for covering plants with polyethylene film spread over wire hoops along the crop rows. The rolls of film are dispensed from an ingenious handmade cart by hand or by tractor. The manufacturer reports that the method, first attempted on large crops of tomatoes and squash in 1958 resulted in costs of

about 4 cents per plant. The film is unrolled over long rows of grape wire hoops arched over the plants, and held in place with dirt on either side and at the ends of the rows. Ventilation can be provided by drilling holes on both sides and in the center of the wound-up rolls, through all thicknesses. When unrolled, the openings form a regular pattern and admit a small amount of rain water to supplement the moisture that condenses inside the plastic covering.

Packaged Planetary Transmission

Fairbanks, Morse & Co., Magneto Division, Beloit, Wis. has announced a new packaged drive designed to provide automatic starting in either forward or reverse without gear shifting. The 3⅞ by 4$^{9}/_{16}$-in. combination clutch and forward-reverse transmission is available for mounting directly to the crankshaft extensions of 1½ to 7-hp gasoline engines.

In operation forward drive is engaged automatically at a pre-determined engine speed by a built-in centrifugal clutch. As

operating speed is reached, centrifugal force overcomes resistance of two retainer springs, allowing the shoes to contact the clutch drum. Resultant drag causes special cam-shaped shoe-mounting brackets to climb the clutch drive pins. This engages the shoes tightly against the drum and increases torque. Speed at which the clutch engages and releases can be controlled simply by changing two retainer springs.

To reverse the drive, engine speed is slowed to the point where the centrifugal clutch disengages. Mechanical braking pressure is then applied to the brake drum assembly. As the transmission stops, the crankshaft continues to drive the sun gear, reversing the direction of the ring gear (and clutch drum assembly with V-belt sheave) through the intermediate pinions. To return to forward rotation, the mechanical brake is released and the engine accelerated to the clutch engagement speed.

(Continued on page 296)

. . . New Products

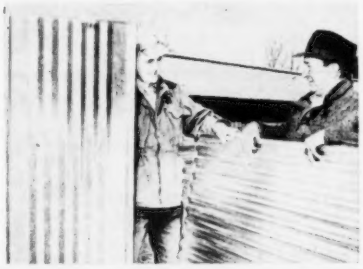
(Continued from page 295)

Concrete Drilling Tool

Bill Jack Scientific Instrument Co., Solana Beach, Calif., has announced a new drilling tool designed to provide one-inch-a-minute speeds in drilling holes in concrete. The pounding action of the tool operates at the rate of 4,000 to 7,000 impulses a minute while the drill bit revolves at 650 to 1200 rpm. The manufacturer reports that the new tool combines rock-shattering action of a star drill and mallet with the usual drill's rotary action. The portable tool is designed to drill holes from ½ to 4 in. in diameter, weighs 30 lb, and operates on 115-volt household current or from a small portable 1.5 KW gasoline generator, either a-c or d-c current.

New Roofing Products

Aluminum Company of America, 771 Alcoa Bldg., Pittsburgh 19, Pa., has introduced two new aluminum roofing products named Rib and 4-V and designed for strength and attractive appearance. The Rib

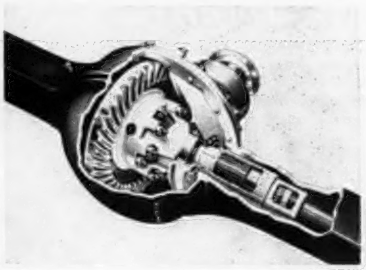


sheet features trapezoidal corrugations and a diamond embossed finish and is available in lengths up to 16 ft. It has a width of 50.75 in., providing 48 in. of coverage. It is also available, upon special inquiry, in longer lengths.

The new 4-V roofing, designed primarily for rural applications, features two V-crimps on each edge, with six corrugations between the V's. It is stucco embossed, and provides 24 in. of coverage. It is available in lengths from 6 to 24 ft. The manufacturer offers a 30-year warranty against corrosion on both products.

Traction Equalizer

Transmission and Axle Division of Rockwell-Standard Corp., 100-400 Clark Ave., Detroit 32, Mich., has introduced a new traction-improving device, known as the traction equalizer, for off-the-highway and over-the-highway units. The new unit is designed to impart to the wheel with the best road adhesion a substantial increase in



tractive effort. It is reported that the new device will propel a vehicle even if one of the driving wheels is completely off the ground. In addition to increased traction, the company reports that the unit provides easy control on curves, slippery pavements and soft ground. Installation is said to be simple. Since the differential nests remains standard, the only new parts required to install the unit are axle shafts and differential cases.

New Tractor Offers Increased Lugging Power

Caterpillar Tractor Co., Peoria, Ill., has introduced a new model D7, series D, tractor featuring greater power, decreased maintenance requirements and higher lugging ability. The new machine is powered by a turbocharged engine and is rated at 140 hp

at the flywheel and 112 hp at the drawbar. Increased lugging ability is attributed to the engine's higher torque rise. The tractor reportedly offers 19.6 percent increase in drawbar pull as the engine lugs down under load, which is 80 percent greater lugging ability than the previous D7 models.

(Continued on page 299)

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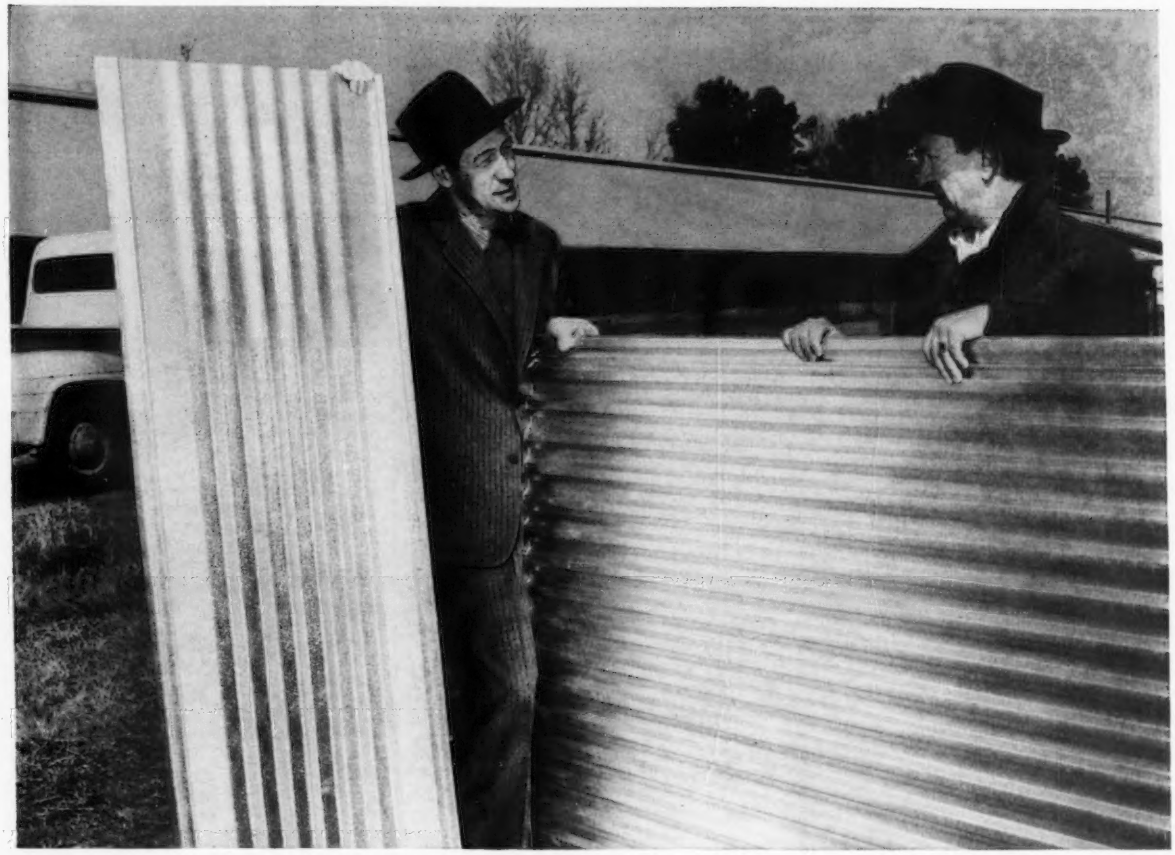

FROM ALCOA RESEARCH: TWO IMPROVED ROOFING SHEETS

Two handsome new aluminum roofing sheets incorporating a wide range of improvements are the latest developments of Alcoa agricultural research.

New Alcoa® Rib Roofing is a smart, modern, diamond-embossed roofing sheet equally adaptable to use on pole buildings and for beautifying the homestead. Farm homemakers will be using it for patio shades, utility room panels, carports, basement walls where mildew is a problem, and other related uses.

Technically, Alcoa Rib Roofing is ideal for these multiple uses. It comes 50¾ in. wide, lays up full 48 in., is extra-heavy gage, comes in lengths from 6 ft to 16 ft, is finished diamond embossed in attractive, deep, flat-top corrugations with a nonsiphon side lap.

Alcoa Rib Roofing has yield strength of 32,000 psi before embossing; pitch of 2.67 in. with 9/16-in. depth; weight approximately 33 lb per sq, is designed to withstand uniform loads of 124 lb per sq ft on 24-in. purlins.

This sheet is stronger than .024-in. corrugated, embossed aluminum sheet under uniform loads, will withstand reasonable bending without breaking and is available with a complete line of accessories. It should be fastened with standard Alcoa Aluminum Nails.

New Alcoa 4-V Roofing is a corrugated, embossed roofing sheet which has many improvements over standard V-drain roofing. It has two V crimps on each edge, six corrugations between V's and a nonsiphon side lap. Alcoa 4-V Roofing comes 26 in. wide, lays up 24 in., is available in lengths 6 ft to 12 ft in .019-in. aluminum.

Its design eliminates "oil canning," "fish mouthing" and opening from expansion. It reduces glare, lays with extreme ease and has better nailing characteristics than its predecessor. Alcoa Aluminum Nails should be used. Complete accessories are available.

Alcoa 4-V Roofing has a typical yield strength of 35,000 psi before embossing, uses ½-in. V's, is corrugated ⅜ in., weighs approximately 29 lb per sq. Use solid deck or nailing strips on 12-in. centers.

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☐ Alcoa Rib Roofing leaflet ☐ Alcoa 4-V Roofing leaflet ☐ One complete set of nine pole-building StePlans* ☐ *Pole Barn Plans Catalog* . . . lists Alcoa plans available to farmers ☐ *Pipelines to Profit*, booklet on portable irrigation ☐ "Right as Rain," 28-min sound-color film on portable irrigation† ☐ "Barn Raising, U.S.A.," 18-min sound-color film on pole-barn construction using aluminum roofing and siding† ☐ Alcoa Farm Gate literature, facts about aluminum gates

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†Films may be borrowed for public showing. Specify dates wanted.

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RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

Row-Crop Sprayer-Duster Shows Promise

Federal-State researchers have developed a sprayer-duster that effectively controls aphids on potatoes and is adaptable for use on several low-growing crops in different row spacings.

The machine has trailing treating booms fastened at right angles to a horizontal tubular drawbar. A universal joint at the connection of each treating boom with the drawbar permits the booms to move horizontally and vertically within rows. This keeps sprayer-duster outlets operating at a uniform height.

Shoes, similar to skis, at the lower end of each boom run in the furrows midway between rows and maintain the delivery outlets in a constant position relative to the ground. The design, employing two sets of spray nozzles and dust outlets, enables accurate treatment of the upper and under foliage of crops.

Vilas D. Young, agricultural engineer, and Joseph C. Chamberlin, entomologist, both of USDA's Agricultural Research Service at Forest Grove, Ore., headed development of the sprayer-duster. Cooperating were the Oregon, Idaho, and Washington Agricultural Experiment Stations, and the Washington State Potato Commission.

Almost complete control of aphids and no significant damage to potato vines, using currently available insecticides, suggested possible use of the equipment on other low-growing crops. Plans have already been made for testing the sprayer-duster on lettuce and broccoli. Cabbage, cauliflower, collards, strawberries, eggplant, lima and string beans are other crops that could be treated with the machine.

Bulk Box Use Spreading in Fruit Industry

Evidence that use of bulk boxes with a capacity of 16 to 25 bu to handle fruit is spreading in most major apple-producing areas of this country is substantiated by a report from AERD of USDA's Agricultural Research Service.

The report says that during the 1957 season an estimated 4,000,000 bu of fruit were moved in bulk boxes, a considerable increase over previous years. Indications are that this trend will continue, according to authors of the report, J. H. Levin and H. P Gaston.

Mr. Levin is head of the Fruit and Vegetable Harvesting Section of the Harvesting and Farm Processing Research Branch of AERD in USDA's Agricultural Research Service. Mr. Gaston is in the Department of Horticulture at Michigan State University.

A partial list of concerns making bulk box handling equipment listed in the report notes: Twenty-three firms that manufacture industrial fork-lift equipment, six tractor companies that make fork-lift units for their tractors, 17 companies that make lift attachments fitting most tractors, three companies that sell lift masts, and seven firms that sell bulk-box dumpers.

The report points out the usefulness of industrial fork-lift trucks to handle bulk boxes.

New Method of Describing Farm Building Plans

A new method has been devised for presenting information about available working plans of farm homes and service buildings offered by the Cooperative Farm Building Plan Exchange.

A single printed sheet, containing illustrative drawings and a brief description of each plan, is made available to county agricultural and home demonstration agents through the State Agricultural Extension Services. The sheets are used in loose-leaf catalogs for distribution to farmers and homemakers who are interested in obtaining plans for erecting new structures or improving existing structures. Directions for obtaining actual plans are printed on the sheets.

The new sheets, known as Miscellaneous Publications, were developed by engineers and architects of USDA's Agricultural Research Service, in cooperation with the Regional Committees of the Exchange.

Building descriptions available are: 3-bedroom houses, M.P. 758, 777, and 778; riding-horse stable, M.P. 755; machinery shed with living quarters in one end, M.P. 774; and pole-type buildings for hay or machinery storage, loafing or other general shelter uses, M.P. 750, 751, 772, and 773.

Descriptions of cattle-handling equipment available include: calf creeps and feeders, M.P. 748, 752, and 757; chute with headgate, M.P. 749; loading chute, M.P. 761; squeeze chute, M.P. 763; cattle stock, M.P. 762; single bull pen, M.P. 754; double bull pen, M.P. 769; cattle hay racks, M.P. 747; mineral feeder with weather vane, M.P. 775; farm gates, M.P. 764, and corrals for beef animals, M.P. 776.

Any of these Miscellaneous Publications may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., for 5 cents each. Nine other sheets are being printed.

BN-2

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. . . New Products

(Continued from page 296)

Bulk Feed Storage Unit

Columbian Steel Tank Co., 1509 West 12th St., Kansas City, Mo. has announced a new self-contained bulk feed storage unit, with an internal auger for elevating or mixing feed within the tank. A combination of 6-in. augers enables the unit to mix feeds, grains and concentrates as the storage tank is loaded; mix them within the tank, unload as needed from the tank and thus make, store and handle formula feeds. Units are available in storage capacities from 3.1 to 10.4 tons, depending on the height of the 6-ft diameter tank.

Self-Propelled Baler and Automatic Bale Thrower

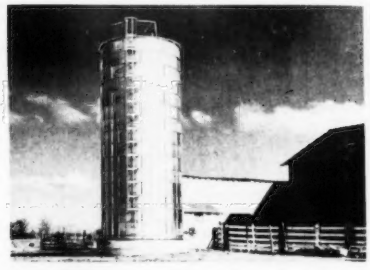
New Holland Machine Co., New Holland, Pa., has announced production of a new self-propelled baler and a new automatic bale thrower. The new baler, powered by a 51-hp engine, is operated from a "cruise control center" located directly in front of

the seated operator on the machine's instrument panel. One lever operates ground speed; another controls baling speed. Three speeds forward give flexibility for field or highway conditions.

The Model 50 automatic bale thrower reportedly tosses bales up to 30-in. in length from bale chamber to trailing wagon. The unit is engine driven and controlled from the tractor by a throttle. Bales are carried over two high speed belts and thrown into the trailing wagon as baling continues. The bale thrower is designed to turn with the trailing wagon for delivering bales into the wagon even on turns.

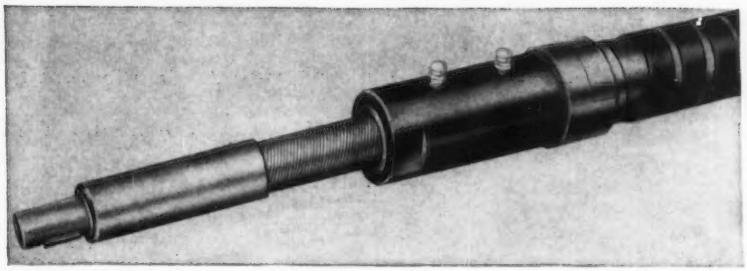
Silo for Wet-Corn Storage

Martin Steel Corp., Mansfield, Ohio, has developed a new steel silo designed specifically for storage of wet corn and all types of high-moisture grains. Featuring auto-



matic bottom unloading, the new silo has been designed with emphasis on reduction of feeding and labor costs. It is available in several sizes. Heavy, reinforced walls are made of rust-resistant steel.

HOW TO SELECT FLEXIBLE SHAFTING FOR POWER DRIVE APPLICATIONS



1¼-inch STOW Power Drive flexible shaft with core assembly pulled out of casing.

For Power Drive applications, the following factors must be considered:

1. Torque (Lb. In.) to be transmitted. (The starting torque should be used in making selections).

2. Operating Speeds (RPM)—If the maximum speed is higher than the rated speed, torque ratings in the table below do not apply. To find the torque capacity for flexible shafts operating at speeds higher than the rated speeds, multiply the maximum dynamic torque capacity by the rated speed, and then divide by the operating speed. (See example).

3. Operating Radius—In making the selection from the table below, the radius of the smallest bend in the flexible shaft should be used.

Ratings — The ratings for flexible shafts shown in the table below apply under the following conditions:

1. When the flexible shaft is adequately supported by clamps along its length. (For unsupported shafts, multiply the calculated torque by a safety factor of 1.6—see example below)

2. When the flexible shaft is operated in the wind-up direction, which tends to tighten the outer layer of wires. (Flexible shafts operated in the unwind direction will transmit only about 60% of the rated torque).

3. When the flexible shaft is in continuous operation. Note: **the ratings are based on temperature rise. When the operation is intermittent, the ratings in the table may be exceeded. Consult Stow Engineers for specific recommendations.**

RATED SPEED R.P.M.	MAXIMUM DYNAMIC TORQUE CAPACITY (LB. IN.) STRAIGHT AND CURVED SHAFTS RADIUS OF CURVATURE IN INCHES									Wgt./ C. Ft.	Core Dia.	Core No. and Type	Shaft Size
	50 to Strgt.	25	20	15	12	10	8	6	5				
4,500	2.4	2.2	2.0	2.0	1.92	1.9	1.7	1.5	1.25	3.0	.124/.128	2049 MH	13
3,800	7 0	6.4	6.0	5.8	5.4	5.0	4.6	3.6	2.0	4.5	.148/.152	2081 MH	15
2,900	9.4	8.6	8.0	7.6	7.0	6.6	6.0	4.8	3.4	7.0	.185/.189	5108 MH	19
2,500	22.0	20.0	18.8	17.6	16.0	15.0	12.6	10.8	9.0	12.5	.247/.252	8924 MH	25
1,800	30.0	28.0	26.4	25.0	23.0	21.0	18.0	14.0		20.0	.308/.313	8925 MH	31
1,800	33.8	31.5	29.7	28.1	25.9	23.6	20.2	15.8		20 0	.308/.313	8969 T	31
1,800	36.0	33.0	31.6	30.0	28.0	26.0	22.0	18.0	11.0	21.0	.324/.329	2034 A	31
1,500	80.0	66.0	63.0	58.0	51.0	46.0	37.0	22.0		28.5	.368/.374	2035 A	38
1,500	60.0	54.0	50.0	46.0	42.0	38.0	30.0	24.0		29.0	.387/.393	8970 MH	40
1,500	90.0	81.0	75.0	69.0	63.0	57.0	45.0	36.0		29.0	.387/.393	8971 T	40
1,150	136.0	110.0	104.0	94.0	80.0	72.0	56.0			50.5	.497/.503	8999 A	50
1,150	148	124	110	92	72	56				53.5	.505/.511	6940 T	50
900	248	200	176	124	84					78.5	.610/.618	6997 T	63
900	220	204	192	180	152	130				80.5	.630/.638	7731 A	63
750	340	224	156	76						117	.747/.753	2056 T	75
600	760	520	420							205	.998/1.004	2057 T	100
440	1,500	720								343	1.298/1.304	2058 T	125

EXAMPLE — How to use the table:

The problem is to transmit ½ H.P. at 1700 RPM through an unsupported flexible shaft in a 25" radius, estimated starting torque 150% of normal operating torque.

1. Calc. Torque (lb. in.)—

$$\frac{HP \times 63000}{RPM} = \frac{.5 \times 63000}{1700} = 18.5$$

2. Correction factor for starting torque 1.5 x 18.5=27.75
3. Correction factor for unsupported shaft 27.75 x 1.6 = 44.4 lb. in.
4. Refer to Table above. Read downward in column under 25" radius until you find a core having a rating of at least 44.4 lb. in. In this case we find that core No. 8970 is rated 54 lb. in. at 1500 RPM. Since the given speed is 1700 RPM, multiply 54 by 1500 and divide by 1700. 54 × 1500 ÷ 1700 = 47.6 lb. in. (rated torque at 1700 RPM). Therefore, Core No. 8970 is correct.

STOW

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The following bulletins have been released recently. Copies may be obtained by writing to author or institution listed with each.

Fundamental Studies on the Improvement of Fertilizer Distributors (1) On the Relations Between the Physical Property and Fluidity of Fertilizer, by M. Wakui. *Studies on the Cultivating System of Winter Cropping on Paddy Fields (1)* On the Function of Ridges in Case of Working Grounds, and *(2)* On the Function of Ridges in Case of Growing Grounds of Crops, by Manabu Wakui, Kozo Takahashi, Kazutomo Ikeda, Tetsuo Tsukidate and Teizo Kindaichi. Each bulletin carries a summary in English. The Tohoku National Agricultural Experiment Station, Morioka, Japan.

Plans for Tilt-Up Above Ground Silo and Tilt-Up Below Ground Silo. University of Missouri, Agricultural Extension Service, Columbia, Mo.

What's New in Pallet Fasteners, by E. George Stern. Bulletin No. 37, January 1959. *Better Utilization of Wood Through Assembly with Improved Fasteners,* by E. George Stern. Bulletin No. 38, April 1959. The Wood Research Laboratory, Virginia Polytechnic Institute, Engineering Experiment Station, Blacksburg, Va.

Personalized Buildings for Your Farmstead by Your Farm Bureau Co-op. Indiana Farm Bureau Co-operative Association, Inc., Indianapolis, Ind.

An Averaging-Type Meter for Measuring the Moisture Content of Hay in the Windrow, by G. W. Isaacs and D. E. Wiant. Article 41-64, reprinted from the Quarterly Bulletin, Vol. 41, No. 3, pages 608 to 613, February 1959. Michigan Agricultural Experiment Station, Michigan State University, East Lansing, Mich.

Flow of Bulk Solids, Progress Report, by A. W. Jenike, P. J. Elsey, and R. H. Woolley. Bulletin No. 96, December 1958. 31 pages, price $1.00. Utah Engineering Experiment Station, The University of Utah, Salt Lake City, Utah.

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Measuring Irrigation Water, by Verne H. Scott and Clyde E. Houston. Circular No. 473. California Agricultural Experiment Station and Agricultural Extension Service, University of California, Davis, Calif.

Buy Pork Wisely, Use It Well, by James D. Kemp. Circular No. 561. College of Agriculture and Home Economics, University of Kentucky, Lexington, Ky.

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Hungarian Agricultural Review. Vol. VII, No. 3, 1958. Written in English. Orszagos Mezogazdasagi Konyvtar es Dokumentacios Kozpont, Attila utca 53, Budapest I, Hungary.

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A Summary of Kentucky Soil Fertility Experiments, by P. E. Karraker and Harold F. Miller. Bulletin No. 663, June 1958. Kentucky Agricultural Experiment Station, University of Kentucky, Lexington, Ky.

Ventilating Poultry Houses with Fans, by W. E. Matson. Extension Bulletin No. 529, June 1958. Extension Service, Institute of Agricultural Sciences, State College of Washington, Pullman, Wash.

Safeguarding Feeds and Fences, by D. W. Works. Farm Electrification Leaflet No. 44, December 1958. College of Agriculture, University of Idaho, Extension Division, Moscow, Idaho.

Lighting Your Home, by Coral K. Morris, Donald P. Brown, and Dennis E. Wiant. Miscellaneous Series, Circular No. CE-8, September 1958. Cooperative Extension Service, Michigan State University, East Lansing, Mich.

The Bulk Harvesting of Orchard Fruit, by G. E. Tidbury. 38-page booklet, January 14, 1959. Price, five shillings postpaid. Commonwealth Agricultural Bureaux, Farnham Royal, Bucks, England.

A Field-Plot Sprinkler Irrigator, by J. P. Riley and J. W. Wolfe. Miscellaneous Paper No. 57, September 1958. Agricultural Experiment Station, Oregon State College, Corvallis, Ore.

A Progress Report on the Development of a Mechanical Cucumber Harvester, by B. A. Stout and S. K. Ries. Article 41-74, reprinted from the Quarterly Bulletin, Vol. 41, No. 3, pages 699 to 718, February 1959. Michigan Agricultural Experiment Station, Michigan State University, East Lansing, Mich.

Fertility Investigations on the Black Earth Wheatlands of the Darling Downs, Queensland, by S. A. Waring, W. E. Fox, and L. J. H. Teakle.

I. Moisture Accumulation Under Short Fallow. Reprint No. 14, reprinted from the Australian Journal of Agricultural Research, Vol. 9, No. 2, pages 205 to 216, 1958. *II. Moisture and Evapotranspiration in Relation to the Wheat Crop.* Reprint No. 15, reprinted from the Australian Journal of Agricultural Research, Vol. 9, No. 6, pages 717-729, 1958.

Both reprints are available from the University of Queensland, Department of Agriculture, Brisbane, Australia.

Herringbone and Other Milking Systems, by C. R. Hoglund, J. S. Boyd, and W. W. Snyder. Article 41-75, reprinted from the Quarterly Bulletin, Vol. 41, No. 3, February 1959. Michigan Agricultural Experiment Station, Michigan State University, East Lansing, Mich.

Cropping for Fodder Conservation and Pasture Production in the Wool-growing Areas of Western Queensland, by P. J. Skerman. University of Queensland Papers, Vol. 1, No. 3, 1958, Reprint No. 16. Price, eight shillings. The University of Queensland Press, Brisbane, Australia.

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Albrecht, Kenneth J.—Student, agr. eng. dept., University of Minnesota, St. Paul, Minn.

Ayers, Tom A.—Agr. power engr., P. G. and E., Yosemite Dist. of San Joaquin Valley Div., P.O. Box 719, Merced, Calif.

Bucher, Philip N.—Jr. mech. engr., New Holland Machine Div., Sperry Rand Corp. (Mail) 1611 Oregon Pike, Lancaster, Pa.

Carlson, Eric A.—Mgr. of standards, production dept., Ralston Purina Co. (Mail) 1119 S. Berry Rd., Webster Groves 19, Mo.

Conklin, Gene — Sales mgr., Farwest Steel, Inc., Box 4036, Station B, Spokane 31, Wash.

Corry, Jack A. — Jr. engr., dept. of irrigation, University of California, Davis Campus, Davis, Calif.

Dickinson, James H. — Area engr., (SCS) USDA. (Mail) 108 Cooper Dr., Somerset, Ky.

Downing, Frank K. — Power sales rep., East Kentucky Rural Elec. Co-op. Corp., Box 555, Winchester, Ky.

Doyle, Robert H.—Eng. spec., (SCS) USDA, 1481 Leestown Rd., Lexington, Ky.

Fenn, William M., Jr. — District serv. supervisor, International Harvester Co., 1986 W. Beaver St., Jacksonville, Fla.

Gil, Luis R.—Ranch owner, Hacienda El Algarrobo, Calle 24, 23 Barquisimeto, Venezuela, S. A. (Mail) c/o Carl Kerekes, D.V.M., 61 N. Point Dr., Avon Lake, Ohio

Grady, John T.—Sales engr., New Departure Div., General Motors Corp., 7-122 General Motors Bldg., Detroit 2, Mich.

Hagen, Donald J.—Asst. product engr., Allis-Chalmers Mfg. Co. (Mail) 7007 W. Coldspring Rd., Milwaukee 19, Wis.

Kennicutt, Robert B. — Proj. engr., Electric Wheel Co., Div. of Firestone Tire & Rubber Co. (Mail) 26 Granview Dr., Quincy, Ill.

Koluvek, Paul K.—Agr. engr., (SCS) USDA. (Mail) R.R. 2, Box 165, Brawley, Calif.

Locke, James R. — Asst. public health engr., District 3, Missouri Div. of Health. (Mail) Tebbetts, Mo.

Maxwell, Robert R.—Account exec., Western Advertising Agency, 610 Wisconsin Ave., Racine, Wis.

Maxwell, Rodney L.—Agr. engr., Cooperative G.L.F., Inc. (Mail) 924 Danby Rd., Ithaca, N. Y.

Miller, Barstow J.—Zone mgr., International Harvester Co. of Canada, Ltd. (Mail) Box 115, Sudbury, Ont., Canada

Pratt, Marvin A. — Farm structures rep., Weyerhaeuser Sales Co., First National Bank Bldg., St. Paul 1, Minn.

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Root, Frank S.—Graduate student in agr. eng., University of Arkansas. (Mail) Apt. 19-B, Camp Neil Martin, Fayetteville, Ark.

Schwartz, Lorrin H.—Product des. engr., Tractor and Implement Div., Ford Motor Co. (Mail) 381 Lorberta Lane, Pontiac, Mich.

Smith, A. C.—Farm power advisor, Pacific Gas and Electric Co., Box 1171, Salinas, Calif.

Vadney, Frank R. — Field rep., Starline Inc. (Mail) 1106 Russell Rd., Willow Grove, Pa.

Wiedemann, Harold T.—Tractor maint. spec., vocational agr. spec. program. (Mail) Agr. Eng. Dept., Texas A. and M. College, College Station, Texas

Zorn, Allen O.—Product des. engr., Brillion Iron Works, Inc. (Mail) 346 Cleveland St., Brillion, Wis.

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Berns, David K.—(University of Nebraska) (Mail) 3420 Dudley, Lincoln, Nebr.

Brown, Fletcher J., Jr.—(New Mexico College of A. & M. Arts) Hydrology dept., U.S. Forest Service. (Mail) Box 978 University Park, N. M.

Cabaniss, James H.—(University of Georgia) (Mail) Maxeys, Ga.

Cook, Raymond L.—(University of Missouri) (Mail) R.R. 1, Gideon, Mo.

Davison, Walter S., Jr.—(University of Missouri) Eng. trainee, (SCS) USDA. (Mail) R.R. 4, Kirksville, Mo.

Dornbusch, August J., Jr.—(Kansas State College) SCS, Box 310, Hiawatha, Kans.

Eeds, Baker B.—(Oklahoma State University) (Mail) Durham, Okla.

Fennewald, John H. — (University of Missouri) (Mail) R.R. 1, Meta, Mo.

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Fitzgerald, Lyndell W.—Eng. ext. dept., Kansas State University, Umberger Hall, Manhattan, Kans.

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Grady, Charles R.—Agr. eng. dept., University of Nebraska, Lincoln, Nebr.

Griffith, Emmett M.—(Oklahoma State University) (Mail) R.R. 2, Hartshorne, Okla.

Haynie, Bobby G.—(University of Arkansas) Arkansas Power and Light Co., Little Rock, Ark.

Heermann, Dale F.—(University of Nebraska) With the U.S. armed forces. (Mail) Scribner, Nebr.

Janski, James L.—(University of Arkansas) (SCS) USDA, Searcy, Ark.

Johnson, Charles B.—(Kansas State College) Farmer, R.R. 2, Concordia, Kans.

Jorgensen, Charles M.—(University of Wisconsin) (Mail) Milltown, Wis.

Lacy, James W.—(University of Georgia) Deere-Acres, Monroe, Ga.

(Continued on page 303)

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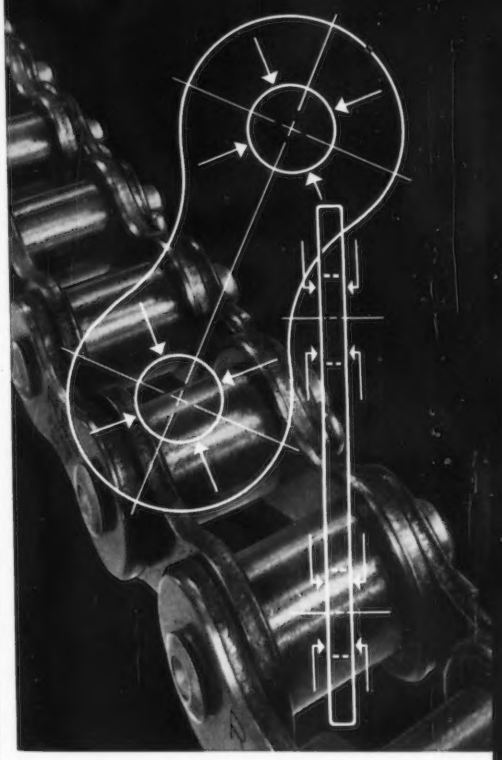

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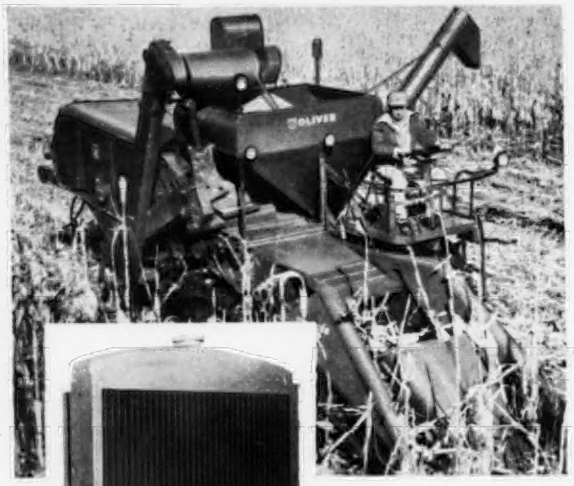

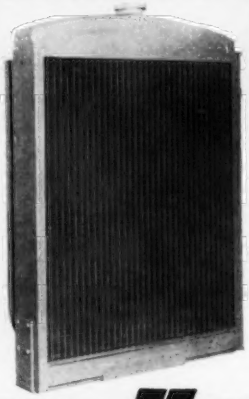

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PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin, the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listing.

POSITIONS OPEN — 1958 — NOVEMBER — O-331-835, 344-838. DECEMBER — O-352-839, 349-841, 349-842, 362-844. 1959—JANUARY—O-418-845. FEBRUARY — O-13-901. MARCH — O-38-903, 39-904, 41-905, 45-906, 45-907. APRIL — O-50-908, 55-909, 58-910, 56-911, 59-912, 71-913.

POSITIONS WANTED — 1958 — NOVEMBER—W-332-55, 324-56, 339-59, 318-60. DECEMBER—W-347-61, 345-62, 346-63, 358-64, 363-65, 364-66. 1959 — JANUARY—W-355-67, 383-68, 411-69, 412-70, 406-71, 419-72, 422-73. FEBRUARY — W-9-1, 17-2, 22-3, 23-4, 20-5. MARCH — W-25-6, 26-7, 33-9, 30-10. APRIL—W-54-11, 70-12, 72-13.

NEW POSITIONS OPEN

SALES ENGINEER for established manufacturer of grain driers, grain handling equipment and produce machinery, in southeastern territory. Age 25-40. Proven sales record on similar types of equipment. Usual personal qualifications for sales engineering. Car and expenses furnished. Insurance program. Salary open. Incentive pay and profit sharing plan. O-77-914

AGRICULTURAL ENGINEER for extension work primarily in power and machinery. Travel approximately half-time. Central state location. Age 25-35. MSAE, or BSAE and 2 years experience. Able to work with people, speak before groups, and prepare extension publications. Two-year appointment to replace engineer going on foreign assignment. Possibility of continued employment. Salary $6,000 or higher. Travel on $8.50 per diem basis. O-49-915

PRODUCT ENGINEER for design and development with growing shortline farm equipment manufacturer in Midwest. Age 28-40. Engineering graduate with 5 to 10 years experience in design, development and field testing of farm machinery. Excellent opportunity for advancement. Position could lead to chief engineer in near future. Salary open. O-42-916

AGRICULTURAL ENGINEER for rural electrification work with a northeastern electric utility. Farm background, BSAE, completed military obligations, under 30, have own car. Cooperative man with initiative, strong desire to get practical answers to problems, and willing to accept responsibility. Prefer some experience, speaking and writing ability. Salary open. O-95-917

AGRICULTURAL SAFETY SPECIALIST for organization and leadership in field on national basis. Midwest location. Age 25-50. BS degree in agriculture as a minimum. Extension or similar experience. Able to meet and work with rural leaders. Good opportunity for advancement. Salary $7,500 to $10,000. O-66-918

DESIGN ENGINEER for design and development of automated poultry and hog equipment with division of large manufacturer. Midwest. Age 24-30. BSAE or BSME. No experience required. Good opportunity with expanding engineering department. Salary open. O-97-919

NEW POSITIONS WANTED

FARM EQUIPMENT SALESMAN and branch manager for work with manufacturer, distributor, or consultant. Any location. Married. Age 47. No disability. MS, 1935, Agricultural University Wageningen, Holland. Experience 4 years with former Netherlands Indies Government in rehabilitation of plantations. Farm equipment dealer in Indonesia 8 years. Also acted as consultant for large plantations in Indonesia. Entered US in 1958 under special quota for Dutch workers from Indonesia. World War II enlisted and commissioned service with Netherlands Army in England and Australia. Working knowledge of Dutch, English, German, and French languages. Available on reasonable notice. Salary open. W-64-14

AGRICULTURAL ENGINEER for design, development, research, extension, or teaching in power and machinery, product processing, or mechanical engineering, with manufacturer or public service. Any location. Single. Age 31. No disability. BSAE, 1952, National Taiwan University. MSAE, 1956, Kansas State College. Graduate research assistant 1½ years. Auto mechanic's instructor 6 months. Assistant design engineer one year. Design engineer on farm equipment 3 years. Available on reasonable notice. Salary $6,500. W-83-15

AGRICULTURAL ENGINEER for design, development, service, or writing in power and machinery field with manufacturer in Midwest or East. Married. Age 39. No disability. BSAE, 1949, Pennsylvania State University. Farm background. Experience 3½ years as service manager for wholesale farm equipment distributor; 1½ years in design and development of hydraulic loaders; 4½ years as design engineer on spraying and planting equipment. War experience in Army, 3 years. Available on 2 weeks notice. Salary open. W-84-16

AGRICULTURAL ENGINEER for teaching or research in power and machinery with college. Any location. Married. Age 28. No disability. BSAE, 1952, Pennsylvania State University. MSME, 1958 Bradley University. Design and layout 5 years, mostly on diesel and gas turbine engines. Some work on other components of tractors, grain drills and corn planters. Military service 2 years in Army. Available fall semester, 1959. Salary open. W-86-17

AGRICULTURAL ENGINEER for design, development, or research in power and machinery with manufacturer, experiment station, or federal agency. Location Midwest. Married. Age 33. No disability. BSAE, 1952, University of Illinois. Experience one year on testing farm equipment, 3½ years on experimental stress analysis. Military service 2 years in Army. Available on reasonable notice. Salary open. W-67-18

AGRICULTURAL ENGINEER for design, development, or writing in farm structures or heavy sheet metal equipment, with industry or federal agency. Midwest. Prefer large city or adjacent area. Married. Age 29. No disability. Travel up to 25%. Farm background. Stress analysis engineer 2 months. Instructor in Army structural steel school 2 years. Design engineer 4½ years on oil industry tanks, bulk trailers and other heavy sheet metal equipment. Available on reasonable notice. Salary $7,200 minimum. W-80-19

AGRICULTURAL ENGINEER for research, teaching, development, or design in power and machinery with manufacturer, college, or experiment station. Any location. Married. Age 24. No disability. BSAE, 1958; MSAE expected May 1959, Iowa State College. Farm background. Cooperative training program 24 months. Graduate research program. Teaching farm machinery management one quarter. Available in June. Salary open. W-98-20

AGRICULTURAL ENGINEER for design, development, research, or teaching in power and machinery with industry or public service. Northeast location preferred. Married. Age 25. No disability. BSAE, 1958; MSAE expected August 1959, University of Maine. Farm background, including 2 years full time farming. Summer work 2 years on mechanical blueberry harvester development. Available September 1. Salary open. W-99-21

AGRICULTURAL ENGINEER for design, development, or research in power and machinery with manufacturer in California, Midwest or Midsouth. Married. No disability. Tool design for farm equipment production, 2 years. Farm equipment design 4 years. War service in Navy, nearly 4 years. Available on reasonable notice. Salary $7,200. W-100-22

AGRICULTURAL ENGINEER for extension, teaching, or research in power and machinery with a college in USA or possessions. Married. Age 35. No disability. BSAE, 1951, Oklahoma State University. MSAE, 1953; PhD in Agricultural Engineering, 1956, Michigan State University. Experience in college teaching 3 years; graduate assistant 4 years; auto mechanic 2 summers. Currently assistant professor of farm power and machinery, University of Shiraz, Iran. Available in September. Salary open. W-101-23

AGRICULTURAL ENGINEER for design, development, or research in power and machinery or farm structures with manufacturer or consultant, preferably in Midwest. Married. Age 26. No disability. BSAE, 1957, Iowa State College. Farm background. One summer with farm equipment manufacturer, one with rural building contractor. On active duty with Navy, commissioned service, since graduation, as operations and communications officer aboard ship. Available August 1. W-102-24

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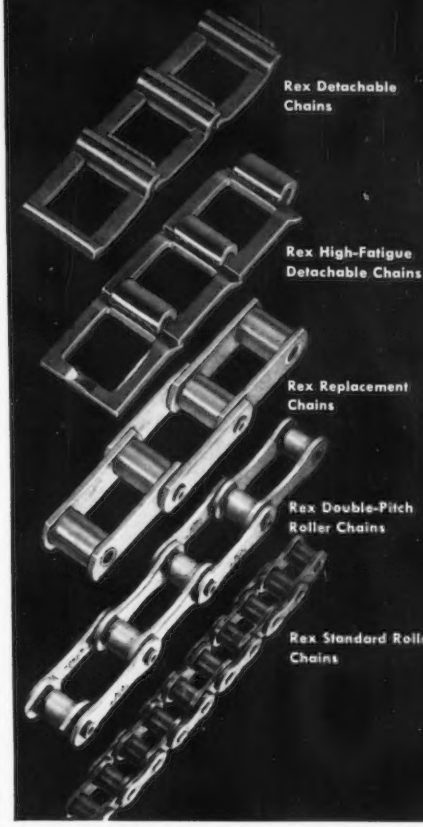

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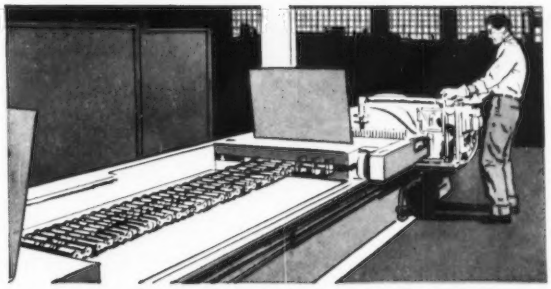
Use LINK-BELT chain . . . built to top farm machine standards as determined by field and lab tests

LINK-BELT's recommendation of the best drive or conveying chain for your machine is based on experience gained in field tests under actual working conditions. And Link-Belt is in the best position to make unbiased proposals because our line of chain, sprockets and attachments is *complete*. Horsepower, loading, speed, impact—every requirement can be met to enable your machine to maintain rated performance and efficiency throughout its life.

Yes, Link-Belt's unmatched facilities, experience and services are your best assurance of quality chain, properly applied. Next time you're considering a drive or conveyor application, our chain specialists will be glad to work with your engineers. For facts and prompt service, call your nearby Link-Belt office.



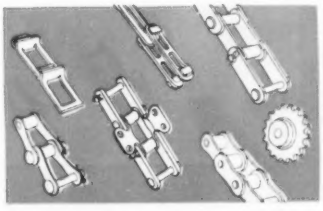
ACCURATE MANUFACTURE — Modern specialized machines allow the economies of large-scale production. Continuous inspections safeguard tolerance and finish of every link of chain. With these extensive facilities, Link-Belt has ample capacity to meet production schedules.

LABORATORY CONTROL — Every chain carrying the Link-Belt trade mark meets rigid uniformity specifications. Our modern laboratory continuously explores new refinements to increase chain life. It is located at the world's largest plant manufacturing drive and conveying chain.

LINK-BELT

14,958

CHAINS AND SPROCKETS

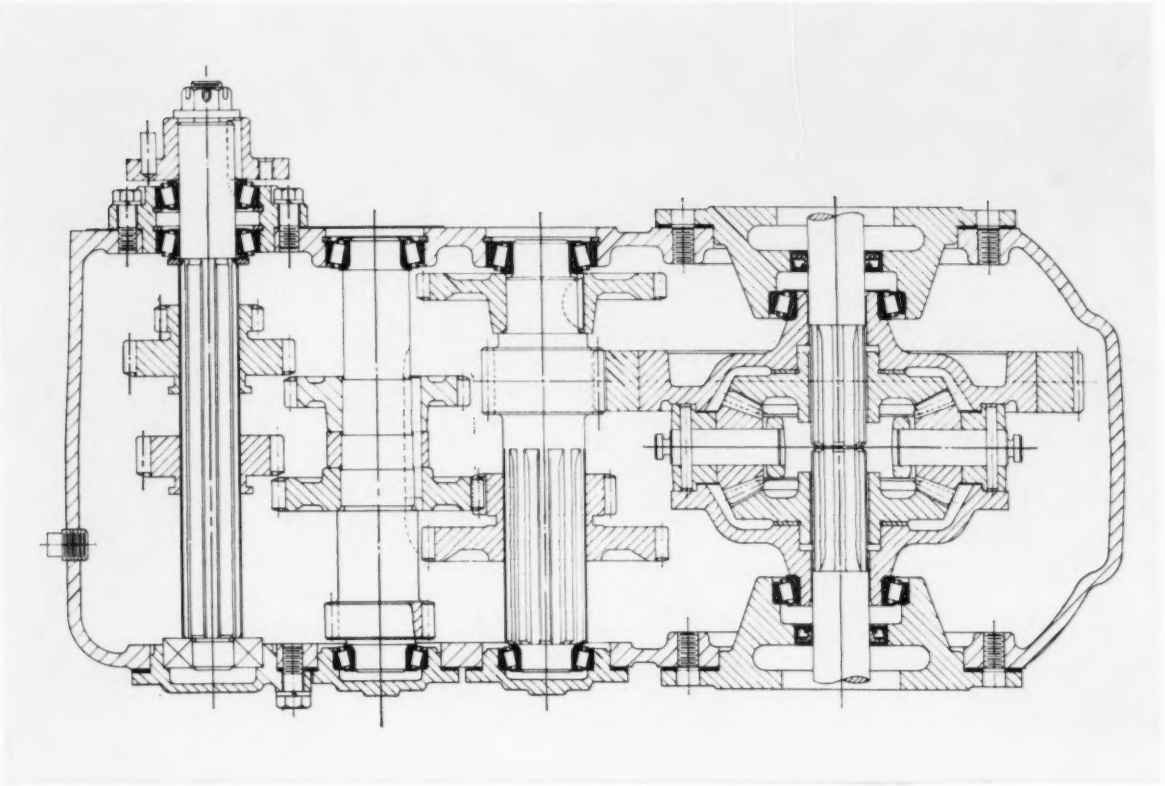


COMPLETE LINE of agricultural chains, sprockets and attachments permits cost-saving specialization — offers the right chain for all conveyor and drive needs.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

John Deere gets maximum design economy in new cotton picker transmission

Uses Timken® bearings on all shafts for greater rigidity, longer life



BY using Timken® tapered roller bearings on all four shafts in the transmission of their new 99 cotton picker, John Deere engineers get maximum design economy. And they achieve greater rigidity, longer life at lowest cost. Timken bearings provide rigid support for shafts, keep gears positively aligned. In fact, no other bearing can give equal capacity at the price. Here's why:

Timken bearings are *tapered* to take all combinations of loads, both radial and thrust. And full line contact between rollers and races gives Timken bearings *extra* load-carrying capacity. Most important—Timken bearings are geometrically designed to roll true and *precision* manufactured to live up to their design.

And what's more, by holding shafts concentric with their housings, Timken bearings make seals more effective in keeping dirt out, lubricant in. Timken bearings are made of nickel-rich steel for extra toughness. To be sure it's the finest, we make it ourselves . . . America's only bearing maker that does.

Timken bearings solve three of your big problems: 1) combination loads; 2) dirt; 3) ease of operation. And from the wide variety of Timken bearing sizes and capacities, you can get the one bearing best suited for each position —the one that will most effectively meet all requirements.

More economical and compact designs are big reasons why more engineers are standardizing on Timken bearings. Timken Company engineers will gladly work with you on your designs. They've developed new methods for calculating bearing loads to meet the needs of various types of farm machines working under many different operating conditions. Write: The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◯ AND THRUST ◎ LOADS OR ANY COMBINATION

The farmer's assurance of better design

Tapered Roller TIMKEN BEARING EQUIPPED